THE UNIVERSE IS MAGNETICALLY DYNAMIC WITH COSMIC EXPLOSIONS DRIVEN BY EXTERNAL MAGNETIC FIELDS

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ABSTRACT

Theoretical models of cosmic explosions (such as stellar explosions) and galactic rotation curves are essential cornerstones of astrophysics, serving as primary diagnostic tools for understanding stellar mechanisms, the distribution of matter, and the fundamental structure of the universe. However, in this lengthy research paper, we have provided robust, up-to-date empirical data on stellar explosions and the rotation curve phenomenon, based on modern observations. The objective analysis of observational data not only exposed the fundamental flaws in conventional models of stellar explosions and rotation curves but also refuted foundational paradigms in astrophysics and cosmology. Alternative models have been proposed.

[Note: this article is subject to continued editing]

PART ONE: THE DEFECTIVE MODELS OF COSMIC EXPLOSIONS

Introduction

Stellar explosion, well- known as supernova is an extremely important astronomical process. It is the cornerstone of stellar evolution and cosmic element distribution. But, despite many systematic studies and theoretical models, the deep flaws and fundamental defects in the understanding of the mechanisms driving cosmological explosions are abundantly obvious. First of all, stellar explosions are not represented by a single equation, but by a complex system of mathematical physics, primarily involving general relativistic hydrodynamics, the equation of state (EOS) of dense matter, and neutrino radiation transport. For Type Ia supernovae, the core principle is the Chandrasekhar limit. All these models are hypothetically assuming, supernova explosions as symmetrical, spherical events. Yet, modern observations show these stellar deaths as chaotic, "lopsided," and asymmetric, involving complex, multidimensional magnetohydrodynamics that fail to produce energetic explosions, creating a conflict between theoretical simulations and observed morphologies.

The improper mathematical models had made the process of stellar explosion extremely complicated pseudo physics, and the reason has to do with the lack of correct physical foundations. Before clarifying why the current stellar explosion models are complicated pseudo-mathematical physics, I must emphasise the following. First of all, in the history of astrophysics, there have been many promising models that proved consistent in simulations, but were later refuted by new data. That is because, although mathemtical models are indispensable requirement, representing precise description of phenomena, they are not pure reality, rather they are inherent approximations of reality. Furthermore, and most importantly, mathematical models can create the biggest and most complicated distortion of reality, if the underlying physical principles they're built on are fundamentally flawed or incomplete.

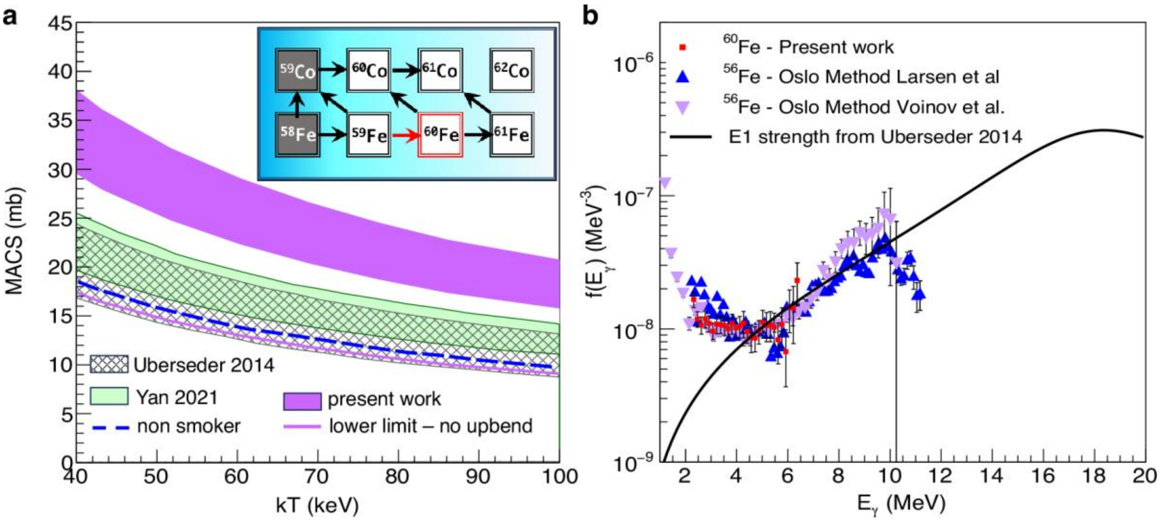
Therefore, accurate models can only be constructed based on observations and empirical data, not models driven solely from mathematical logic; models must describe how things work in reality, not in a hypothetical sense. In other words, true physical model depends on its underlying physics; if the physics is wrong, the model isn't a true reflection of nature, even if its mathematical formulation is useful in simulation.

Nonetheless, theoretical models of star explosions are centered mainly on core collapse of massive stars (typically > 8 solar masses) where, after nuclear fuel is exhausted, the iron core collapses under its own gravity. This rapid, inward contraction—taking only seconds—creates a dense neutron star or black hole, releasing immense energy that reverses the infalling material into a violent, outward explosion. Recent observations, however, like **SN 1987A, SN 1999em, SN 2006V & 2006au, SN 2010jl, SN 2013fs, SN 2014J, ASASSN-15lh, SN 2018is, SN2021yfj, SN 2023ixf, SN 2024ggi and discoveries around stars like SBW1 & Sher, and AT2025ulz,** directly challenging these theoretical models by revealing asymmetric shapes, double explosions, and unusual light curves, suggesting different physics processes, and certainly not a simple spherical collapses. Note, that stars are spherical in shape and if their explosion happens as a result of core-collapse, then the explosion has to expand outward in a near-perfect sphere, "period". Yet, all observations show non-spherical shapes of supernovae (like olive-shaped), implying external forces are crucial, not core bounce. Moreover, while theoretical models assume that Shock wave should emerge quickly after core collapse, observations (SN 2023ixf), show a significant delay (Delayed Shock Breakout). Namely, the spherical symmetry explosion models have proven to be inadequate for capturing the complexities of real explosions. What's more, it is assumed that type Ia SNe happen when a white dwarf hits the Chandrasekhar limit (1.4 solar masses) and explodes once, but observations (SN 2018iss) show a subluminous, double-peaked event (Type Ia Double Detonations) suggesting that a shell is detonating first, triggering the main explosion without reaching the mass limit, a mechanism that cannot be explained by standard models. Furthermore, theoretical models assume that a Core-collapse supernovae should form a continuous range of the so-called neutron stars (NSs) and black holes (BHs), yet observations show a distinct mass gap exists, or what is known as the Neutron Star/Black Hole Mass Gap (heaviest NSs ~2 $M_\odot$, lightest BHs ~5 $M_\odot$), indicating different explosion mechanism. Additionally, theories assume neutrinos should trigger most core-collapse supernovae (CCSN), but this assumption can neither explain the non-spherical remanats nor can predict the failed SNe (no explosion). Also, the efficiency of the energy transfer from neutrinos to the shock wave is an unsolved puzzle. Simulations failed to replicate observed explosion energies, since the energy deposition required for shock revival always exceeds the one achieved in simulations.

So, to sum up the arguments, the deep flaws and fundamental defects in the supernova theories and supernova paradigm are obvious, stemming from enormous observations that show explosions aren't perfectly spherical, but rather asymmetric (like olive-shaped), debunking older models; delayed shock breakouts, and unexpected brightness variations, complicating the simple picture of a star blowing apart, pointing clearly to the true physical process. The second part of this research provides the alternative model for stellar explosions, based exclusively on laboratory-induced empirical evidence. But, let us first address in brief details, the differences between theoretical models of stellar explosions and the actual observations. Definitely, by examining these enormous, recent observations, the fundamental defects will become abundantly clear, and easy to draw the only rational conclusion. Specifically, the current dominant paradigm, which involves two main pathways: core collapse of massive stars (Type II) or runaway fusion in white dwarfs (Type Ia), has nothing to do with the physical reality of stellar explosions.

Observational Data Disclose Deep Flaws & Fundamental Defects:

The standard model for Type Ia supernovae (SNe Ia) posits that the vast majority of a supernova's visible light is powered by heat from the radioactive decay chain of nickel-56, which decays into cobalt-56 and finally to stable iron-56. This process releases energy, with the peak luminosity and subsequent light curve powered specifically by the decay of nickel-56 and cobalt-56. For many stellar explosions, the light curve (the graph of brightness over time) cannot be solely explained by ^{56}Ni decay. Actually, assuming all the power comes exclusively from 56Ni, decay overestimates the nickel mass produced in these events. Some of the brightest supernovae observed (SLSNe) require an impossibly large amount of nickel if powered only by radioactive decay, and their light curves are too narrow to fit the pair-instability models which predict large ^{56}Ni production. However, recent studies indicate that nuclear physics models, specifically those predicting the production of radioactive isotopes like Iron-60 in the exploded stars are inconsistent with observations- actual production rates potentially higher by a factor of two. On the other hand, while radioactive decay ^{56}Ni → ^{56}Co → ^{56}Fe is thought to power supernova light curves, new measurements suggest that neutron-capture rates on iron isotopes in massive stars are not accurately modelled, requiring a fundamental revision of stellar evolution theory. For instance, research from FRIB and MSU highlights that current models cannot reconcile the production of radioactive iron-60 with observational gamma-ray data. Iron-60 (^{60}Fe) production raised serious questions about core-collapse supernova theories (CCSNT), not just regarding uncertainties in nuclear physics.



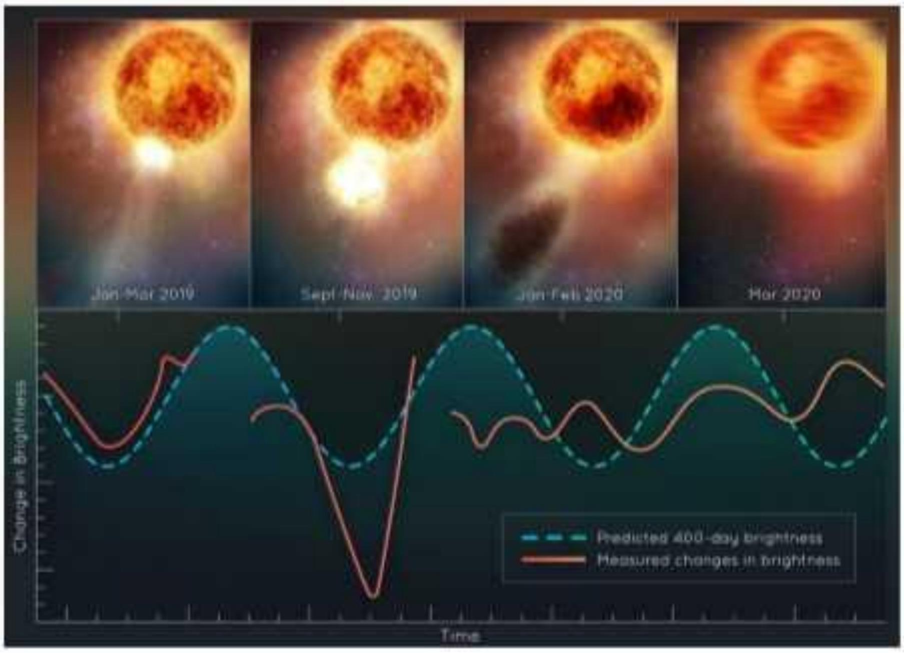
A Maxwellian Averaged Cross Section (MACS) of the ^{59}Fe(n,γ) ^{60}Fe reaction as a function of neutron energy.[1]

By using beta-Oslo method to measure nuclear reaction rates, it was found that the production of Iron-60 within massive stars during explosion to be twice as much as what theoretical models predicted. Detailed experiments, notably from late 2024 and 2025, demonstrating that Iron-60 (^{60}Fe) production in massive stars is enhanced. The enhanced production of iron is pointing to serious issues in the stellar explosion models, with new experiments focusing on the crucial ^{59}Fe(η,γ) ^{60}Fe reaction using techniques like the β-Oslo method to better constrain nuclear properties.

These findings show the following. First, current theoretical understanding of core-collapse supernovae need major revision to match observational reality. Principally, the massive increase in the production of ^{60}Fe points to missing physics and incorrect assumptions of theoretical models, implying that crucial parameters in stellar explosion are misrepresented in simulations. Second, this rare radioactive isotope of iron is a key tracer of the explosion of stars, and accurately modeling its creation is vital for understanding how heavy elements are forged and distributed in the universe, namely because ^{60}Fe is a crucial factor in the process of stellar nucleosynthesis. Note, that the exact cosmic factories (like neutron star mergers vs. supernovae) and the detailed nuclear reactions (especially for rare isotopes and the *r*-process) that create elements heavier than iron remain to be big puzzles in nuclear astrophysics. And, recent findings show that certain nuclear reactions (e.g., neutron capture on iron-59) are misunderstood, with new data suggesting models underestimate these rates by up to a factor of two. Also, gamma-ray measurements of titanium-44 have shown conflicts with expected yields from supernova models. Additionally, observations of Type Ia supernovae (using INTEGRAL) have shown that explosions ignite from the outside, rather than at the core, challenging conventional radioactive decay models in these events. So, while nuclear decay remains the standard model for powering the late-time light curves of supernovae, observations clearly show that the modeled production and assumed rates of these isotopes are flawed.[1- 3]

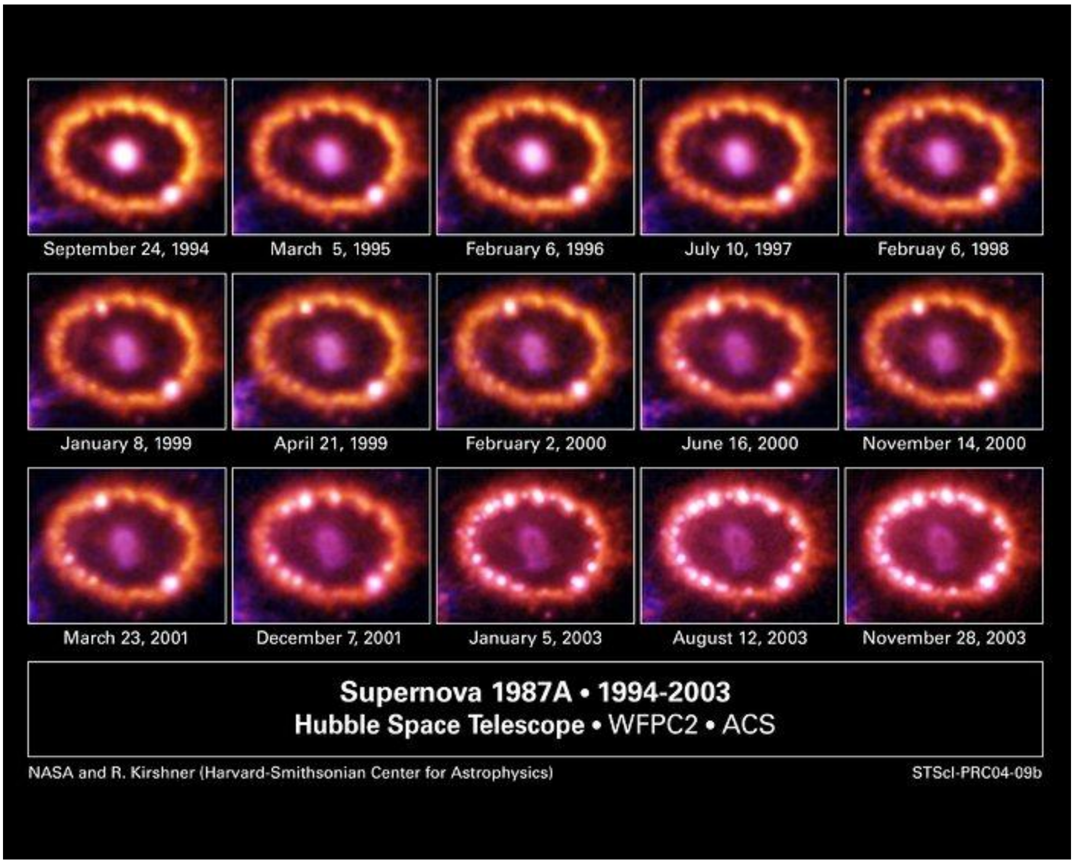
The Fundamental Flaws in Stellar Explosions can be seen in Betelgeuse:

Recent observational data gathered about Betelgeuse, a star with high probability of reaching the complete destruction stage, highlighted serious defects in mainstream stellar explosions. Betelgeuse displayed characteristics, like dramatic dimming and brightening that defied standard models of stellar explosions. These serious flaws associated with Betelgeuse are now considered to be resolved after researchers using Hubble and Germini telescopes claimed to detect the hidden companion star of Betelgeuse, nicknamed Siwara orbiting within its atmosphere. This hidden companion is considered to be the cause for the mysterious six-year dimming cycles of the supergiant star. Note, that Siwarha is hundreds of times smaller than Betelgeuse and very faint (about six magnitudes dimmer in visible light), and it is around 1.5 to 1.6 times the Sun's mass, whereas Betelgeuse is massive, its diameter is roughly 900-950 times that of the Sun. In mid-2023, Betelgeuse reached about 142% of its typical brightness, making it almost 50% brighter than usual. It rose to become the 7th brightest star, up from its usual 10th place. But, between 2019-2020, Betelgeuse underwent a dramatic dimming, dropping by over 60% and becoming nearly as faint as Bellatrix (the third-brightest star in the constellation Orion). This dramatic decline in brightness is believed to be caused by a massive dust cloud ejected from it, obscuring its light as it moved away. However, according to basic astrophysics, the brightness of a star is fundamentally determined by its mass, size and temperature (internal properties). In other words, a star's luminosity is supposed to be directly tied to its internal processes, primarily to nuclear fusion in its core, which generates immense energy, and its physical properties like mass, temperature, and size. These are the basic factors influencing how much light a star emits. But, despite the domination of the intrinsic factors, the extrinsic ones (surrounding environment) still play a role - a minor one - and it becomes insignificant in case of companion stars that are very tiny. That is because a tiny star's light is too weak and dispersed to significantly alter the perceived brightness of a much larger star, though massive stellar systems or close binaries can create complex visual effects, especially with regard to extremely close and magnetically powerful companions. Thus, star's brightness is affected to a great extent, by its surface area (size) and surface temperature, according to the Stefan-Boltzmann Law, $L = 4\pi R^2\sigma T^4$, where R is the star's radius, T is the effective surface temperature, and σ is the Stefan-Boltzmann constant. This formula relates a star's luminosity to its size and temperature, treating the star as a blackbody radiator, and it is crucial for determining stellar properties like radius or temperature when other values are known. Therefore, huge stars have vastly more surface area to emit light, and spreads out as it travels. In other words, the apparent brightness drops dramatically with distance, according to the inverse-square law. So, based on the conventional view, a star's mass determines its brightness (luminosity) and lifespan, with smaller stars burning fuel slowly, staying dimmer and cooler for much longer, while massive stars burn fuel rapidly, becoming incredibly hot, luminous, and having shorter lives, ultimately shining with enormous energy. Evidently, even if we accept that Siwarha is no longer a hypothetical star, but a real, hidden companion star, it is still cannot be used as proof to explain the huge dimming and brightening cycles of Betelgeuse. The explanation is a desperate one and cannot possibly be considered as a scientifically valid argument, especially that the major dimming in 2019-2020, wasn’t just typical variability; it involved huge starspots and a colossal surface mass ejection, a never-before-seen event where similar star "blew its top" ejecting a huge chunk of its visible surface. Betelgeuse expelled 400 billion times the mass of a typical solar coronal mass ejection (CME), a chunk weighing several times more than our moon. "*We’ve never before seen a huge mass ejection of the surface of a star. We are left with something going on that we don't completely understand.*" Definitely, it is not premature to assume, that the brightness variation of Betelgeuse is not related to its hidden companion, but rather to a lack of realistic stellar astrophysics.[4]

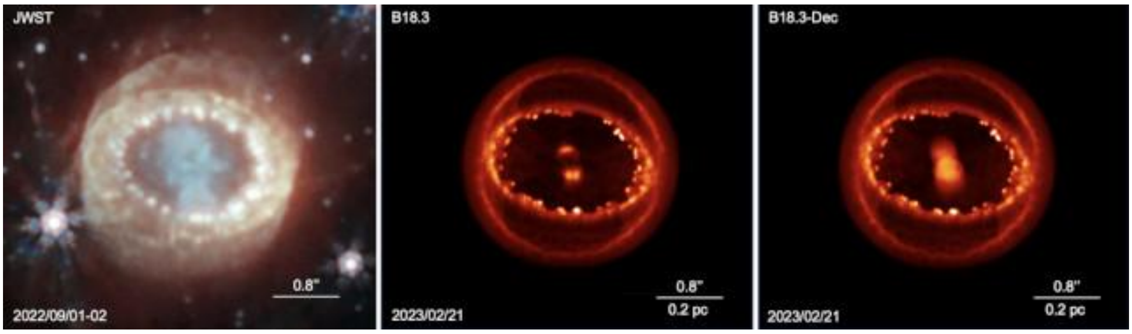


Credit: NASA / ESA / Elizabeth Wheatley (STScI)

SN 1987A: SN 1987A was the closest (visible to the naked eyes), and the best-studied a star-explosion event in nearly 400 years. As, usual, the images below reveal a highly asymmetric explosion, not a perfect sphere with evidence showing bipolar jets, a structured hourglass shape, and uneven distribution of elements like nickel and iron, challenging simple spherical explosion models and pointing to different explosion physics than the current one. In fact, not only Hubble Space Telescope, but also James Webb Space Telescope (JWST) and other instruments have confirmed this asymmetry through detailed infrared imaging and spectroscopy, showing jets and unexpected clumpy structures within the expanding debris. Note, that the observations obtained by the James Webb Space Telescope's NIRCam (Near-Infrared Camera) instrument were crucial and revealed that the iron ejected from supernova SN 1987A wasn't distributed homogeneously, but rather concentrated in two separate clumps that were pushed outwards at very high velocities. Also, SN 1987A challenged standard supernova models because its progenitor was a compact blue supergiant, not the expected red supergiant, and its light curve showed a slow rise to peak without the typical plateau, suggesting unusual ejecta structure and composition (like nickel-56 mixing) that defied predictions for a star of its type.

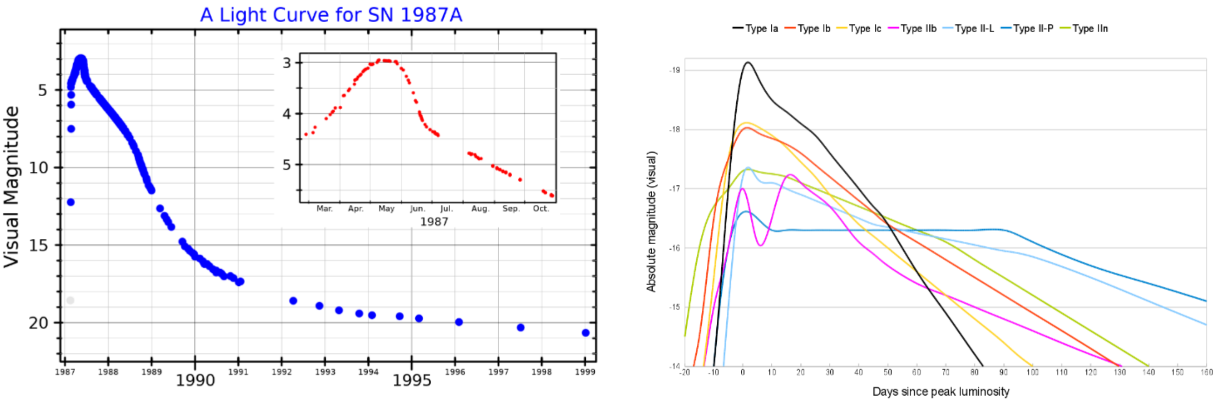


Credit: NASA/ESA, P. Challis, R. Kirshner (Harvard-Smithsonian Center for Astrophysics) and B. Sugerman.[5]



The image[6] shows on the left the supernova SN 1987A remnant as seen by the James Webb Space Telescope, and in the other two panels the simulation of the density distribution of the remnant, which include the iron-rich materials, and the current morphology of that remnant.

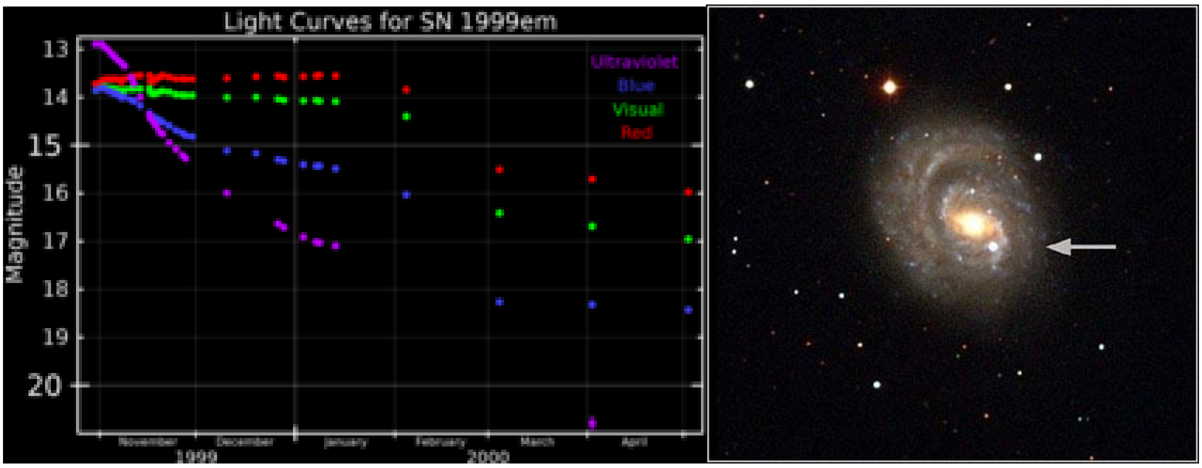
On the other hand, theoretical models predicted red supergiants (puffy, cool) would explode as Type II supernovae, but SN 1987A came from a much hotter, denser blue supergiant (BSG), which required new theories for BSG explosions. Besides that, the light curve had a slow, long rise to peak brightness, unlike the rapid rise expected. Furthermore, it is assumed that Type II supernovae (especially Type II-P) brighten relatively quickly, reaching maximum luminosity (peak optical brightness) in about 2 to 3 weeks. The graphs below show the light curve for SN 1987 and what typical Supernova light curves look like. The light from SN 1987A first reached us on February 23, 1987, and its brightness peaked in mid May, almost 3 months later, and it lacked the characteristic plateau, indicating unusual mixing of radioactive material (^{56}Ni).



SN 1987A Light Curve[7]

Furthermore, Hubble observations revealed rings of gas around the supernova SN 1987A (as shown in the above images), indicating that the star had shed a significant amount of mass (a circumstellar ring) before its core collapsed and exploded. This fact was also confirmed by neutrino detection and observations of the expanding remnant, challenging earlier ideas that stars remained massive until the moment of explosion. This pre-explosion mass loss, creating a ring of gas and dust, became a key feature for understanding massive star evolution, with the explosion's shockwave later slamming into this ring, making it glow brightly. Furthermore, the detection of neutrinos from SN 1987A showed a peculiar, potentially double-peaked signal, posing serious questions to the standard collapse scenarios. On the top of the above, SN 1987A revealed its ejecta weren't uniform, by showing chemical inhomogeneities like iron mixed into upper layers, which defied simple spherical models and pointing to an externally- induced, asymmetric explosion, challenging the uniform ejecta predictions. In essence, SN 1987A was crucial finding that exposed the deep defects in the models of stellar death, and the emergence of unresolved paradoxes at the heart of astrophysics.[8]

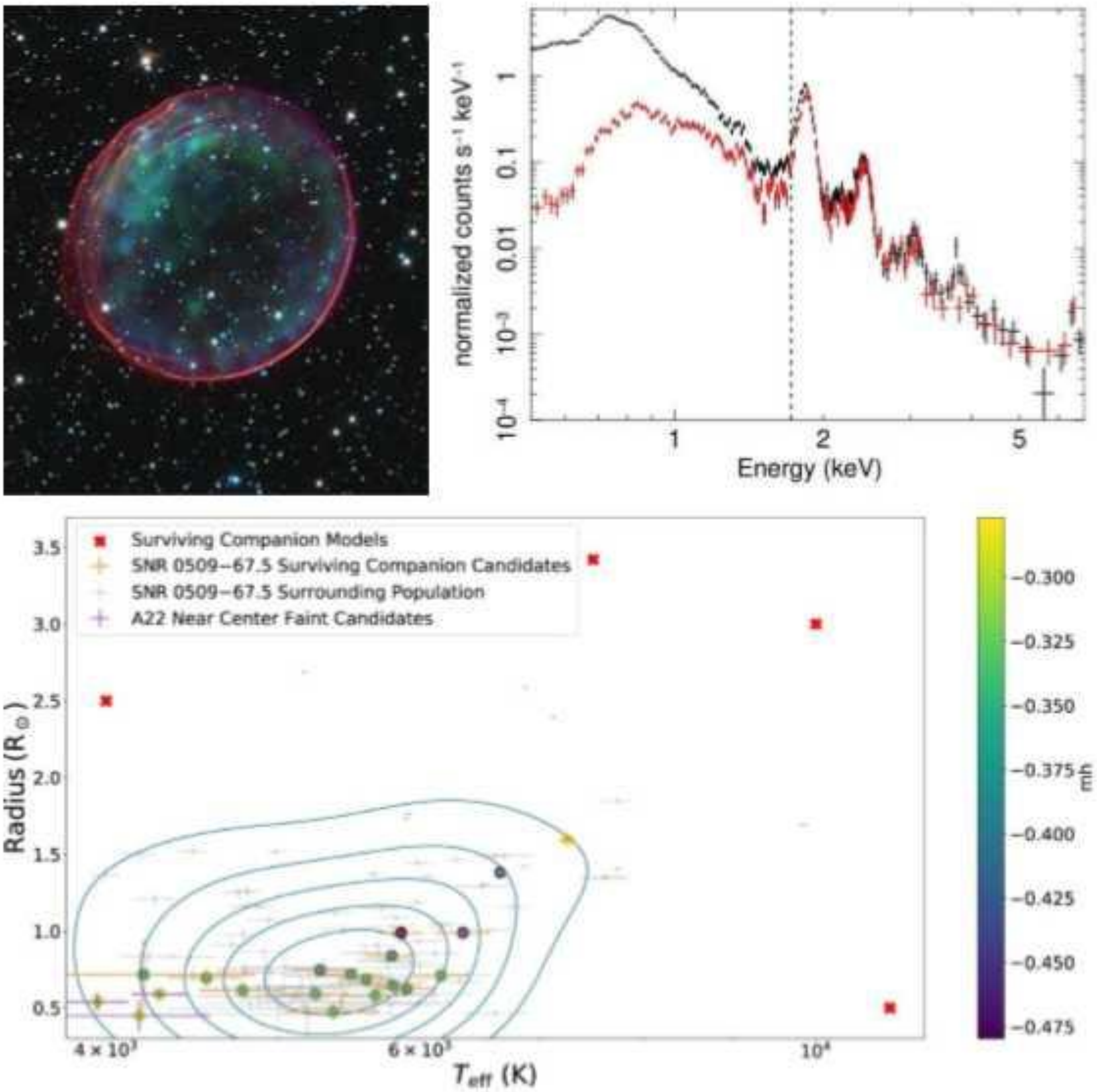
SN 1999em challenged standard models regarding progenitor mass limits, distance measurements, and explosion asymmetries. The key challenges included pre-explosion images failing to identify the predicted massive star, and hydrodynamic models requiring specific distance corrections to match observations, pointing to limitations in understanding Type IIP progenitors, especially that the pre-explosion images of SN 1999em's location in NGC 1637 did not detect a progenitor. Moreover, the hydrodynamic modeling and atmosphere analysis showed inconsistencies between standard models and the initially accepted shorter distances (e.g., 7.85 Mpc), implying a lack in defining the progenitor and explosion parameters to align with observational data. Also, the observed luminosity and color changes could not be explained by simple, standard stellar evolution models for the outer layers of the progenitor, requiring instead specialized modeling of the progenitor's envelope. Obviously, SN 1999em, revealed significant shortcomings in standard, simplified supernova models. Definitely, the failure to identify a progenitor star that matched standard progenitor models in archival data, unquestionably caused significant debate regarding the mass and evolution of the star before explosion.[9]



Light curves in four photometric bands, plotted from data published by Galbany et al. (2016).[10]

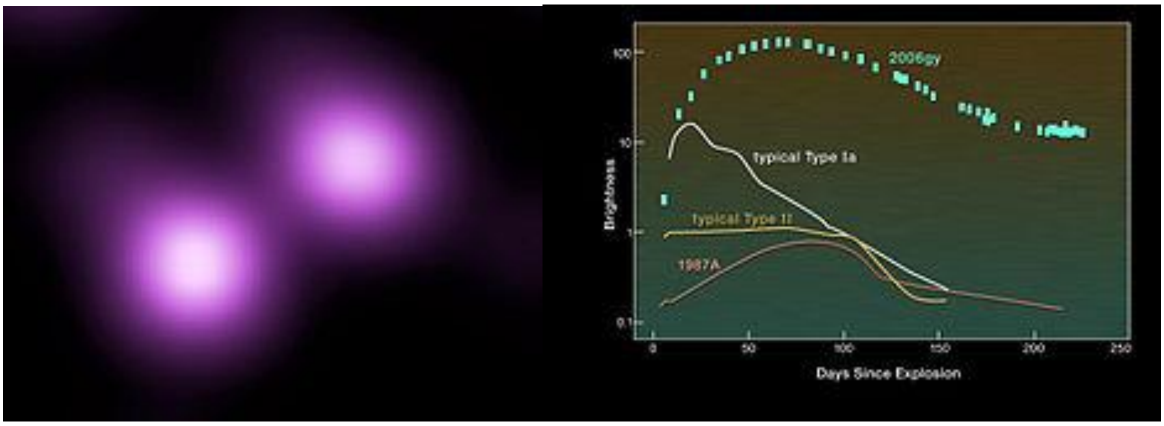
SNR 0509-67.5 was discovered in the Large Magellanic Cloud (LMC) by an X-ray survey using Einstein observatory (Long et al. 1981). 22 years later, the first Chandra observations were conducted, where a circular morhology was found with the bulk of the continuum emission coming from nonthermal origins. And, in 2004, researchers used the European Southern Observatory's Very Large Telescope (ESO's VLT), to observe its destruction by a double detonation, but the absence of a surviving companion star (missing companion star), which standard Type Ia Supernova (SN Ia) models predict it should be observable, challenging simple explosion scenarios.

Other subtleties involve discrepancies in X-ray spectral analysis between observatories, hinting at small-scale composition variations (iron-rich knots) and the remnant's non-uniform expansion due to dense interstellar medium. Essentially, models of SN Ia progenitors have to involve a white dwarf accretion from a companion (like a red giant), with the companion surviving the explosion. Yet, extensive search of stars within the remnant (using Hubble Space Telescope data) found no stars matching the predicted signatures of a surviving companion. An X-ray Proper Motion Study of the LMC SNR 0509-67.5 Furthermore, the empirical data showed the resulting shockwave travels inward, not outward, triggering a second, much stronger detonation in the star's core. That is the first time ever, visual evidence has been obtained that a star is destroyed by detonating twice, where a helium layer ignition triggers a core explosion. Hence, SNR 0509-67.5 has to be considered as another valuable evidence showing the fundamental flaws of SN Ia models. Double detonation: new image shows remains of star destroyed by pair of explosions.[13]



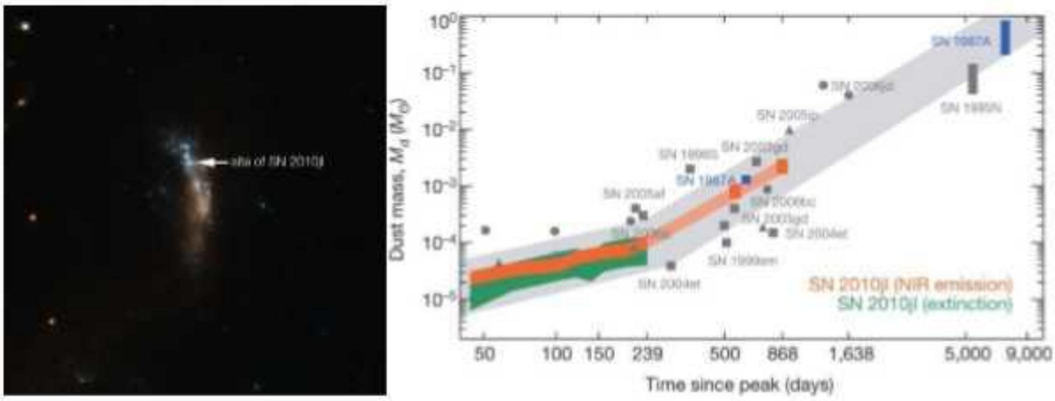
Optical and X-ray Composite Image of SNR 0509-67.5: **Science Credit:** NASA, ESA, and B. Schaefer and A. Pagnotta (Louisiana State University, Baton Rouge);**Image Credit:** NASA, ESA, CXC, SAO, the Hubble Heritage Team (STScI/AURA), and J. Hughes (Rutgers University) – HubbleSite: Gallery, NewsCenter.[11] Supernova remnant SNR 0509-67.5 investigated with Chandra. No Surviving SN Ia Companion in SNR 0509-67.5: Stellar Population Characterization and Comparison to Models – IOPscience.[12]

SN 2006V and SN 2006au: Supernovae SN 2006V and SN 2006au, showed similar light curve shapes and spectra to SN 1987A. And, the Blue Supergiant (BSG) explosions presented serious challenges, since they were brighter, bluer, and had much higher expansion velocities than expected. The persistent blue color, narrow lines, and weak Hα absorption in SN 2006V, in particular, challenged the standard model, suggesting asymmetric ejecta and clumpy structures. Moreover, the ejecta expanded much faster than in the case of SN 1987A, and that required more energy input, noted Harvard University.[13]



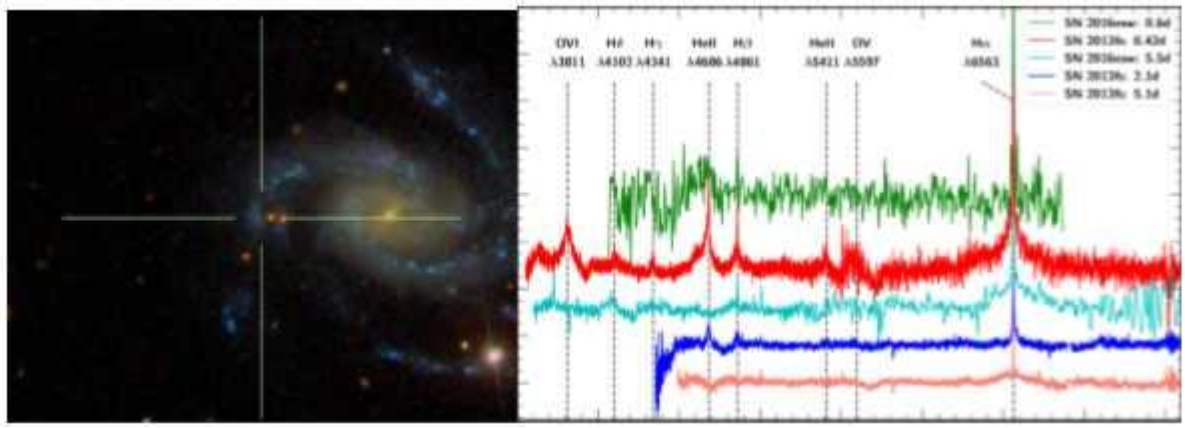
SN 2006gy (right) and the nucleus of its galaxy NGC 1260, X-ray image from the Chandra X-ray Observatory. Light Curve of SN 2006gy, NASA/CXC/UC Berkeley, N.'Smith et al Harvard-Smithsonian Center for Astrophysics.[14]

SN 2010jl: SN 2010jl, is another exploded star that challenged existing theories primarily by revealing unexpected characteristics of its circumstellar material (CSM) and the process of dust formation. It showed rapid formation of dust grains in the cool, dense shell behind the supernova's shock front, occurring within 40 to 240 days of the explosion. The rapid condensation of a significant mass of dust (including very large grains, some larger than 1 micrometer) challenged models that predicted slower dust formation or a minimal dust yield in the harsh, hot supernova environment. Moreover, the evolution of the hydrogen emission lines showed complex, time-dependent blueshifts and asymmetries, suggesting large-scale asymmetries in the CSM. Also, the observations indicated that the "progenitor star" ejected a massive cocoon of gas, likely exceeding 10 solar masses, in the decades prior to the explosion. This high pre-supernova mass loss (at a rate of 1-2 solar masses per year) was significantly larger than generally expected for typical stellar winds. The X-ray and optical data provided the first direct evidence of the supernova blast wave heating and ionizing the surrounding material, with the blast wave eventually breaking out of the gas cocoon. These features point to a more dynamic and potentially non-spherical explosion and surrounding environment than simple, spherically symmetric models assumed.[15]



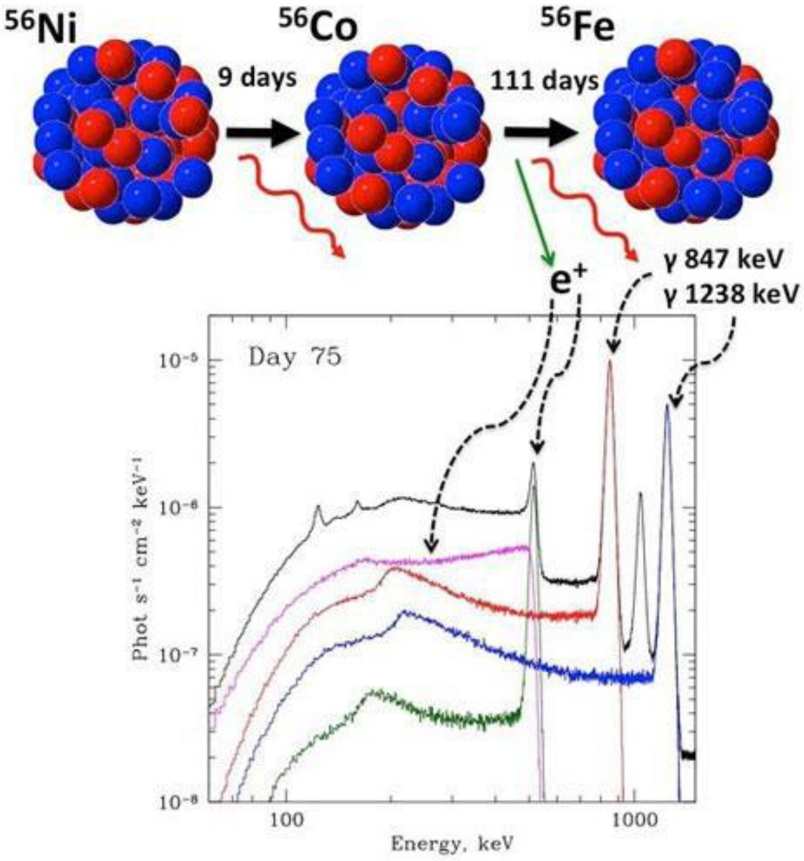
This image from the NASA/ESA Hubble Space Telescope shows the irregular dwarf galaxy UGC 5189A. This star-forming galaxy was the site of the bright supernova SN 2010jl. **Credit:** ESA/Hubble & NASA. Figure on the right, **Credit:** Nature.[16]

SN 2013fs (also known as iPTF13dqy): The observed data about SN 2013fs posed a direct challenge to theoretical models of supernovae by showing signs of Dense Circumstellar Material (CSM) very close to the star just months – not thousands of years- before explosion, and the CSM wasn't a smooth, extended wind but rather a dense, confined shell. Actually, the flash spectroscopy provided unprecedented detail of a dense layer of material (CSM) around the star, confirming extremely high mass loss rates just a short time before its death, which is totally unexpected according to the theory of dying stars, especially supermassive ones. This discovery like so many others highlightes the need for a realistic theoretical models of the explosion mechanism of stars, because the rapid, unstable mass-loss events and the formation of dense, compact CSM shells refute the conventional theory. Actually, even if we assume that the mainstream theory is correct, the core's collapse cannot affect the outer layers significantly on a short timescales. Obviously, these findings are contradictions to the long-held view that core-collapse is the crucial event that triggers the catastrophic explosion of a massive star.[17]



The supernova 2013fs located in a blue, star-forming area (the red point sources in the vicinity are foreground stars), which is apparently a part of one of the major arms of the spiral host NGC 7610. **Caption and credit:** Yaron et al 2017.[18]

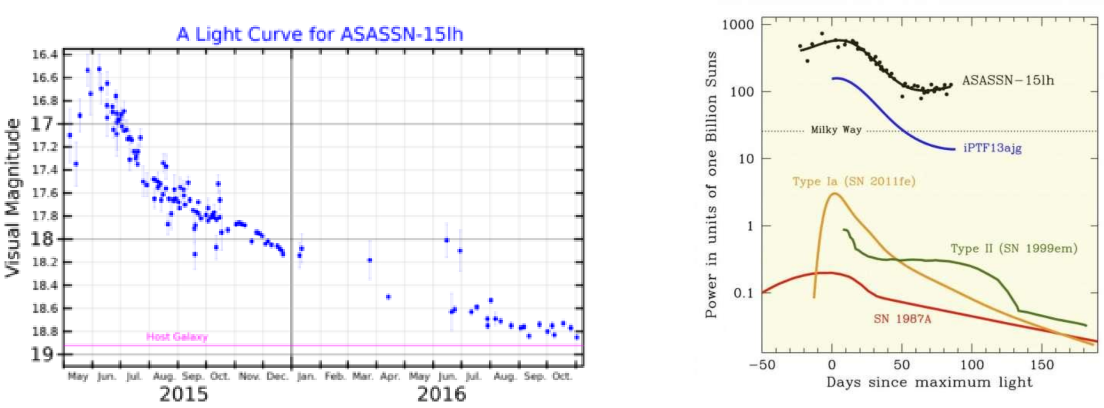
SN 2014J: Characterized as a Type Ia supernova, located approximately 11.5 million light-years (or about 3.5 megaparsecs) away in the nearby M82 galaxy. SN 2014J, was considered a mysterious or weird supernova, due to a lack of x-rays emission. Telescopes like Chandra detected almost no X-rays emission, indicating a surprisingly clean environment and also, the pre-explosion Hubble images found no bright companion star, while X-ray/radio non-detections limited mass-loss rates, ruling out some progenitor scenarios. Noticeably, the absence of X-rays contradicted theoretical models where the white dwarf is supposed to steal or accumulate mass from a Sun-like star, as this would typically produce X-rays. In addition to the lack of X-rays emission, SN 2014J showed peculiar plume of ^{56}Ni ejected at high velocity, something which is not predicted by conventional models. The International Gamma-Ray Astrophysical Laboratory (INTEGRAL) detected strong gamma-ray lines from radioactive ^{56}Ni decay, and found a significant portion (0.03-0.08 solar masses) ejected in a fast-moving plume, which is something inconsistent with standard explosion simulations where this material is typically mixed within the debris, and the gamma-ray signal was surprisingly faint compared to optical brightness. Additionally, only less than two weeks after, SN2014J flared up, researchers of Roland Diehl's Group at the Garching-based Max Planck Institute for Extraterrestrial Physics, discovered- with *INTEGRAL*- two characteristic gamma-ray lines, corresponding to the radioactive decay of nickel (^{56}Ni). The researchers pointed out that the radioactive material must have been near the surface of the explosion, otherwise the signal would not have been able to penetrate the supernova, and it would not have been possible to see it at such an early point in time. Clearly, the detection of ^{56}Ni near the surface of SN2014J shortly after explosion (~20 days) shows a double detonation or surface-initiated explosion. That is to say, the surface ignites first, triggering the main explosion, and not a center-outward thermonuclear burn. This evaluation is very accurate, and it is a decisive evidence flying in the face of the widely held belief about explosion of stars. In other words, the observational data was interpreted correctly, and must be considered as crucial evidence that show explosion of stars do not ignite in their cores, rather on their surfaces.



Chain reaction: The decay path ^{56}Ni → ^{56}Co → ^{56}Fe releases large amounts of energy in the form of gamma-ray photons and positrons. **Credit:** Churazov et al.[19]

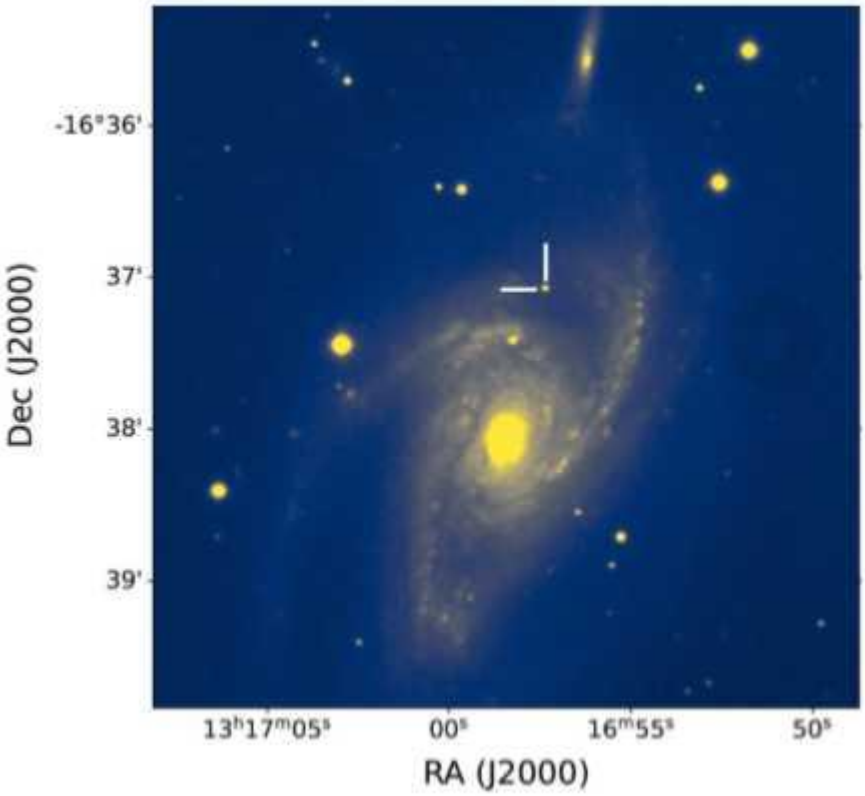
However, it is important to point out, that current simulations (especially 3D models) always produce growth rates of the explosive energy which are too low to account for the observed amounts of synthesize ^{56}Ni. In addition to ^{56}Ni producing too little energy, discrepancies also exist due to uncertainties in explosion timing, distance, and dust extinction in observations, making it difficult to rely solely on nickel decay for all types of supernova light curves. Nevertheless, the failure is very clear in case of stripped-envelope supernovae (SESNe), which show significantly higher nickel masses ("nickel mass problem"). And, the Ultra-stripped Supernovae (USSNe) events are extra evidence confirming the unrealistic nature of stellar explosion models. These events show a similar "nickel problem" where the required ^{56}Ni to power the light curve is inconsistent with the low ejecta mass, indicating an alternative, non-radioactive mechanism for the peak luminosity. Besides, that observations always require a shallower outward spread (distribution) of ^{56}Ni than standard explosion models produce. The uneven ^{56}Ni distribution is clear evidence that the explosions are not spherical, and the external force plays a very important role in the expolsion process. Furthermore, most supernovae have an extra early peak or excess early light which cannot be explained with simple models, and the light curve fades faster than the decay of ^{56}Co (the product of ^{56}Ni). Thus, these findings are sufficient to discard the spherically symmetric models of core-collapse supernovae.[20]

ASASSN-15lh, discovered in 2015 and initially identified as the most luminous supernova ever recorded, severely challenges standard stellar explosion models due to its extreme brightness, which exceeds typical supernova output by 100 times, and it is 20 times brighter than all stars in the Milky Way combined. Its extreme energy output and long-lasting ultraviolet, brightness pushed the limits of known mechanisms, such as magnetar energy injection or pair-instability. The event released approximately 1.7×10^{52} to 1.9×10^{52} ergs over 550 days, an amount of energy that exceeds most conventional models for super-luminous supernovae (SLSNe). The standard radioactive decay models, such as ^{56}Ni, falied to explain this enormous energy output. Furthermore, unlike many SLSNe that show strong interaction between stellar ejecta and surrounding hydrogen-rich material, ASASSN-15lh's spectra lacked these signatures, making it difficult to explain with traditional circumstellar interaction models. And, contrary to expectation, the host galaxy is a massive, red, and relatively calm galaxy with low star formation, rather than the small, actively forming galaxies where such powerful supernovae are supposed to be found. The unusual features have led to suggestions that the event may not be a supernova at all, but rather a rare Tidal Disruption Event (TDE), where approximatly 200 million to 3 billion solar mass spinning 'black hole' tears apart a passing star. However, the researchers did not directly imaging the hypothetically black hole, but they assumed its existence based on an observed violent and unprecedented light show



A visual band light curve for ASASSN-15lh, plotted from data published by Godoy-Rivera *et al.* (2017).[22] The purple line shows the brightness of the host galaxy. SLSNe (Type Ic), SNSLSN-I: The light curves of ASASSN-15lh and other supernovae for comparison. At maximum, ASASSN-15lh is about 200 times more powerful than a typical Type Ia supernova, and it is more than twice as luminous as the previous record-holding supernova, named iPTF13ajg. **Credit:** The ASAS-SN team.

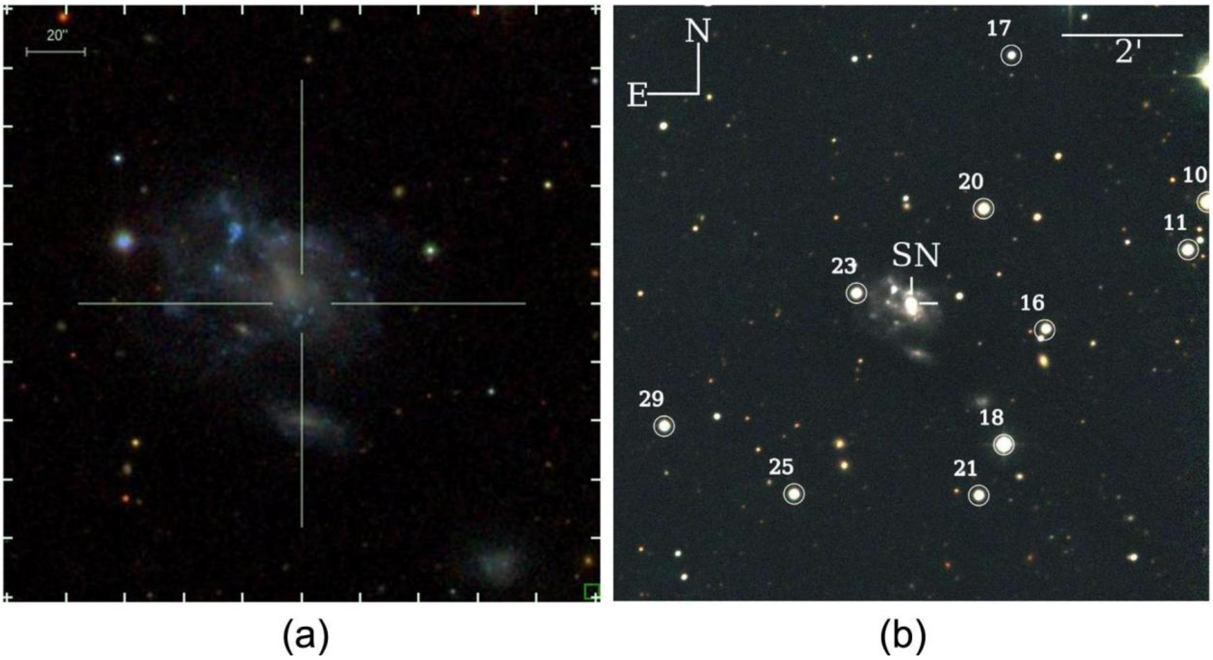
SN 2018is, is supposed to be a low-luminosity Type IIP supernova, yet it showed several properties that challenge standard models for core-collapse supernovae (SNe II), particularly regarding progenitor mass and explosion characteristics. These models struggle to explain the combination of observed features in a single event. Namely, SN 2018is exhibits an unusually steep decline during its photospheric phase compared to most other low-luminosity SNe II. The standard models have difficulty reproducing this specific, short recombination phase within the typical parameter space for this class. The exploded star displays remarkably narrow hydrogen emission lines in its optical and near-infrared spectra, even for a low-luminosity event. This suggests unusual dynamics or interaction with surrounding material which is not easily accounted for by current models. Moreover, its redder colors and a low ratio of Nickel to Iron abundance do not align well with models for an electron-capture supernova scenario, which is an alternative pathway for low-mass progenitors. Additionally, the nebular spectrum shows weak oxygen lines, that lacks features typical of many iron core-collapse events (like He I, C I, and Fe I), adding further complexity to the progenitor identification. Obviously, SN 2018 is contributed to the growing diversity observed within the low-luminosity SN II population, pushing the boundaries of existing theoretical models and highlighting the need for more realistic models of star explosions.[23]



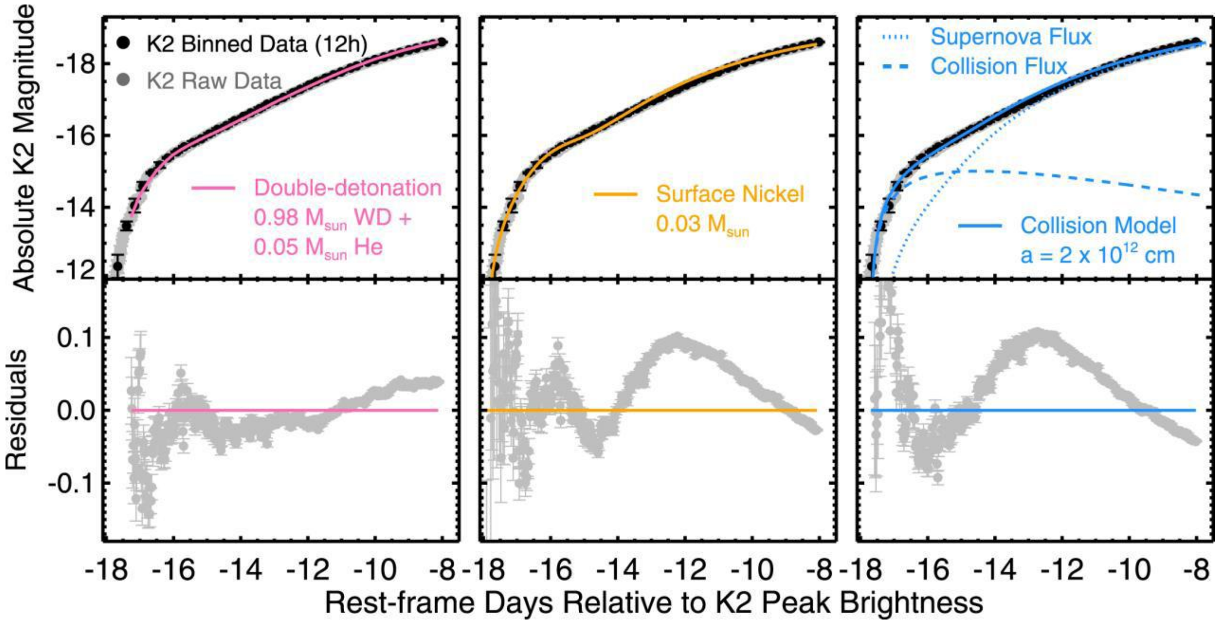
SN 2018is: a low-luminosity type IIP supernova with narrow hydrogen emission lines at early phases. **Credit:** Indian Institute of Astrophysics.[24]

SN 2018oh (ASASSN-18bt) contradicted standard Type Ia supernova models by exhibiting an early, unexpected "blue bump" in its luminosity and a two-component rise in its light curve, rather than a single, smooth, radioactive-heating curve. This suggested additional, unconventional energy sources challenging traditional, simplistic explosion models. The key aspects of how SN 2018oh contradicted standard models can be seen in the following features.

To begin with, in the feature of early excess emission, data from the K2 mission[26] revealed a significant, unexpected brightness increase in the first few days after the explosion, but standard models typically predict a more gradual rise based solely on the decay of ^{56}Ni. The second unexpected feature is the two-component rise. The light curve displayed a rapid initial rise, followed by a slower linear phase, suggesting two different physical mechanisms were responsible for the initial brightness, rather than just one. The other unexpected feature is the absence of companion evidence, because subsequent studies analyzing the nebula (268 days post-max) found no evidence of hydrogen or helium, effectively ruling out a hydrogen-rich donor star (main-sequence or red giant). Basically, the companion star was not identified in late-time spectra. Also, observations showed persistent, significant carbon features in the ejecta for weeks after maximum light, which is unexpected behavior for a fully burned Type Ia event.[27]

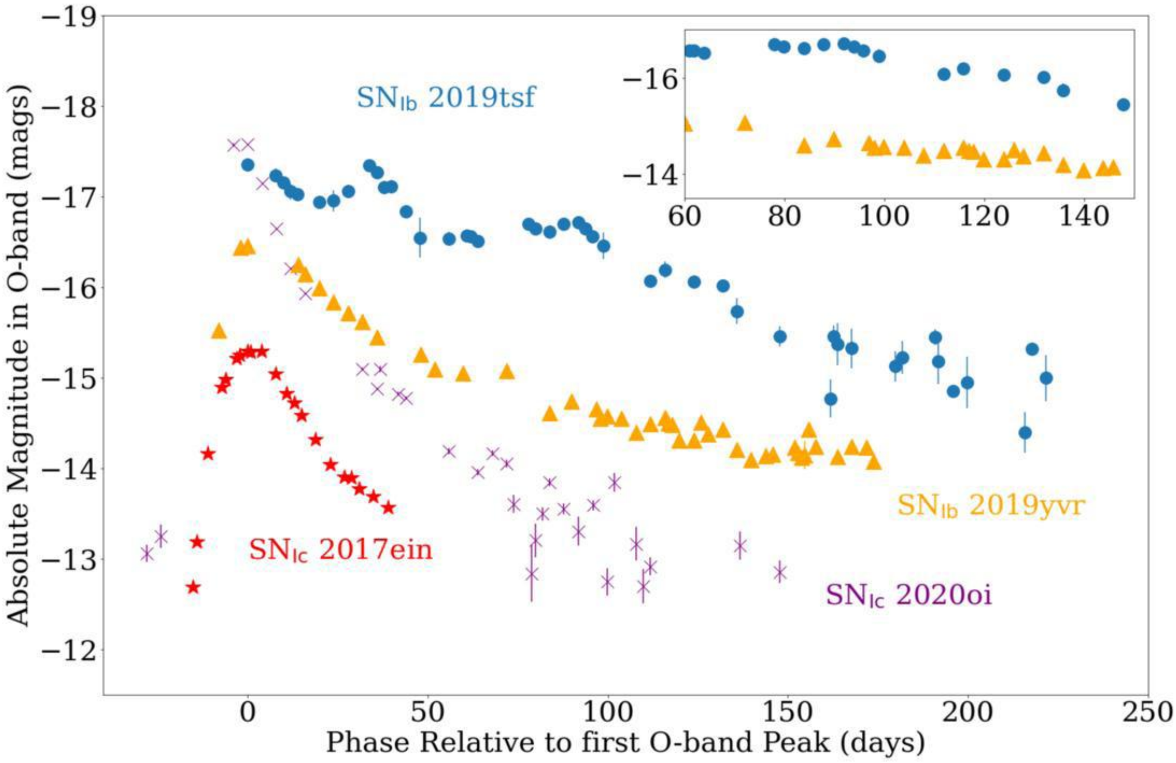


Photometric and Spectroscopic Properties of Type Ia Supernova 2018oh with Early Excess Emission from the Kepler 2 Observations – IOP science.[25]



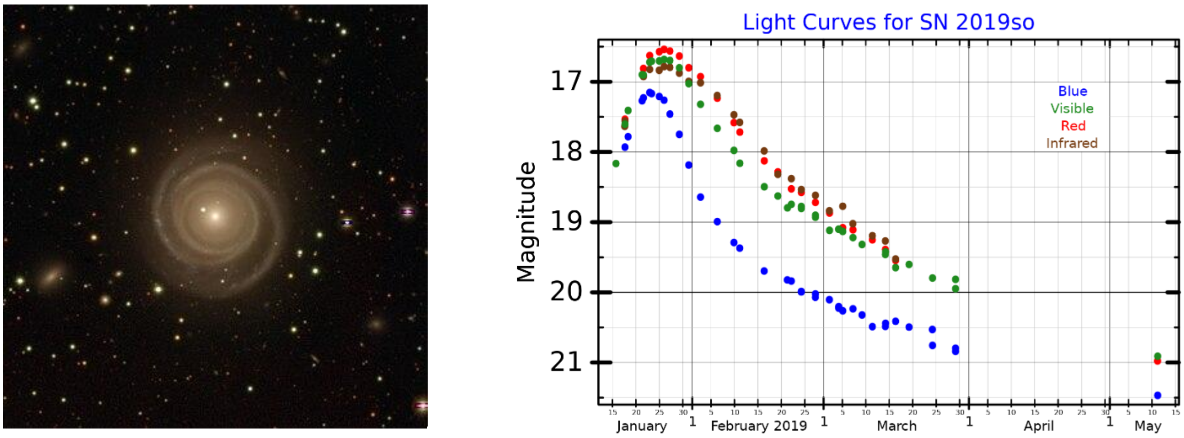
K2 Observations of SN 2018oh Reveal a Two-component Rising Light Curve for a Type Ia Supernova – IOP science.[27]

SN 2019tsf showed sever contradictions to standard models of Type Ib supernovae due to its massive photometric rebrightening and the absence of typical interaction features. Classical thermalization and magnetar powered models failed to simultaneously fit its temproral and spectral properties. It contradicts standard supernova light curve models, and producing instead spectral features inconsistent with progenitor expectations. For instance, it is believed that normal Type Ib supernovae steadily fade after about 20–25 days, but SN 2019tsf showed a three-peaked light curve with a massive rebrightening after about 100 days, while the rise and decline patterns of its light curve do not match either Fast SLSNe I or Slow SLSNe I, indicating unrecognized energy input. SN 2019tsf exhibits luminosities that are higher than predicted by standard models of its ejecta mass and kinetic energy. Radio observations with the VLA revealed a bright, optically thick radio source at late times, which is supposed to be an impossible feature for hydrogen-poor supernovae. Besides that, SN 2019tsf showed no signs of narrow emission lines, something that contradicts the classical view of shock-driven interaction. Additionally, strong ionized features (C II, O I, Mg II) appear where standard models predict weaker or absent lines, and the forbidden lines ([O I], [Ca II]) evolve at unexpected times. However, researchers proposed several mechanisms to explain the energetic anomaly, one theory suggests that the supernova ejecta interact with an asymmetric, warped CSM disk that was disturbed by a third companion in the system.[28]



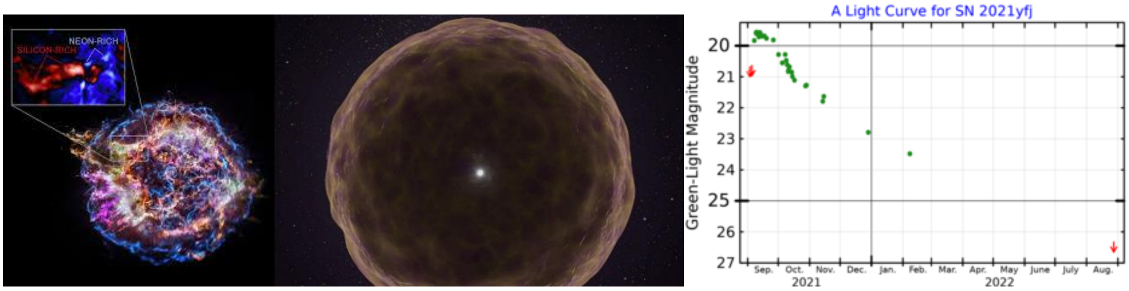
"Absolute *o*-band light curves constructed from the ATLAS sample of SESNe Ib, Ic, IIb."[28]

SN 2019so: SN 2019so was another exploded massive star that defied the expectations of standard models, due to its unusually early and bright ultraviolet (UV) and blue light flash. Key contradictions to models are the following: First, the early flash: standard "sub-Chandrasekhar" or single-degenerate models that cannot explain such an intense early-time peak in UV/blue light without specific, rare conditions. Double-Detonation Evidence: Analysis of its nebular spectra and early light curve suggested it was the result of a double-detonation explosion of a sub-Chandrasekhar-mass star. And, compositional anomalies showed the presence of strong calcium emission in its spectra provided further evidence that this event did not conform to the expectation of SN Ia explosion mechanisms used as standard candles in cosmology.



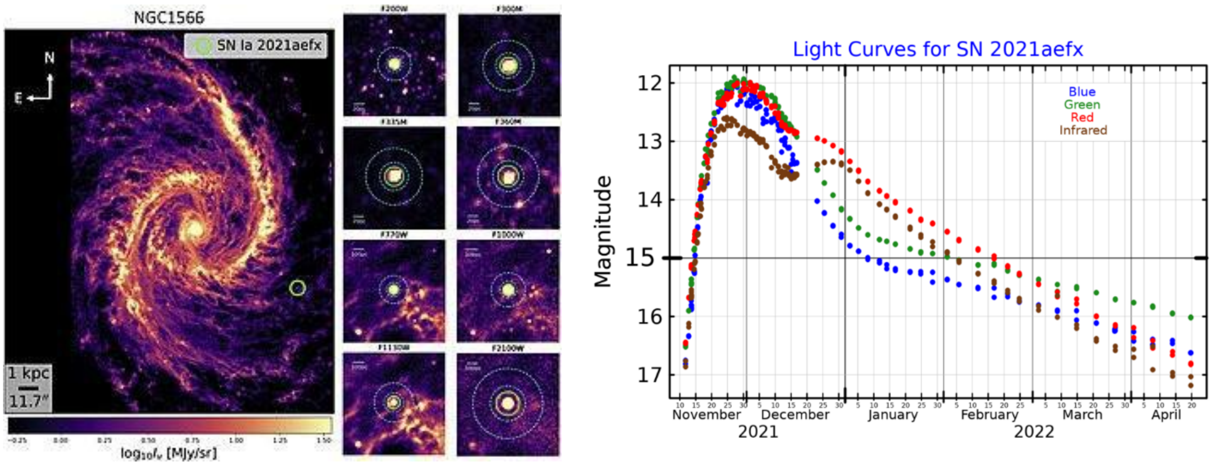
Light curves for SN 2019so in four photometric bands, plotted from data published by Chen *et al.* (2022)[29] SN 2019so occurred within the galaxy NGC 4622, also known as the backward galaxy due to its spiral arms facing the opposite direction to most spiral galaxies.

SN 2021yfj: The other explosive event that shocked the models of stellar explosions was SN2021yfj. It was a massive star stripped bare of its outer layers, revealing its inner silicon and sulfur-rich core, offering the first direct glimpse into a star's hidden structure and challenging existing theories of stellar death. The event proved that stars can lose vast amounts of mass, even down to their silicon layers, before exploding. That is to say, instead of the usual hydrogen and helium signals, its light revealed heavy elements like silicon, sulfur, argon, and showing an extreme mass loss before the final blast.[30]



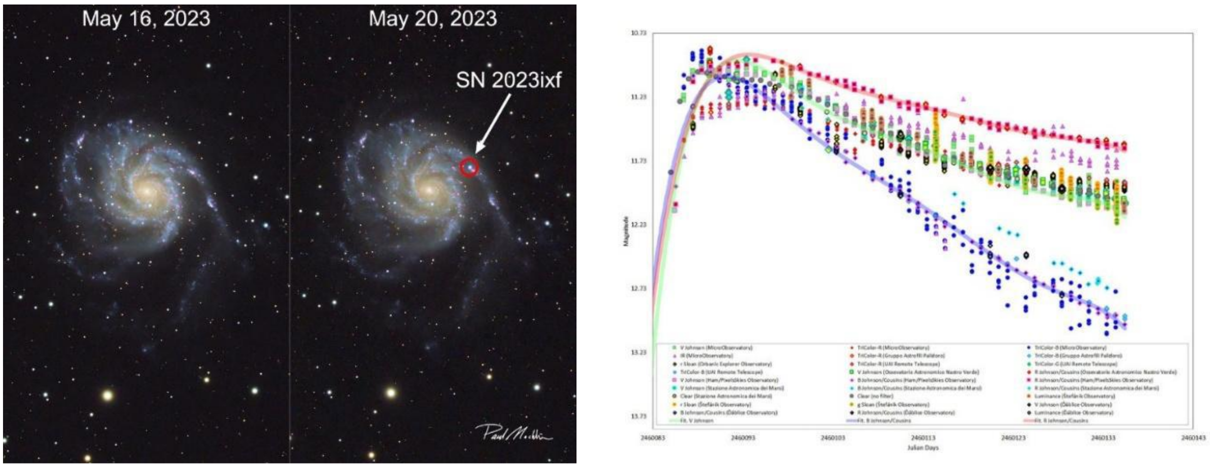
Credit: W.M. Keck Observatory/Adam Makarenko. A green-light curve for SN 2021yfj, plotted from data published by Schulze et al. The red arrows show upper limits from nondetections. The text describes a key plot from research on **SN 2021yfj**, characterized as a unique supernova, showing its brightness (light curve) in green, sourced from Schulze *et al.*[31] Red arrows on the plot indicate moments when the supernova wasn't detected, providing crucial upper limits on its brightness before or during those non-detection periods, revealing an unusual explosion that exposed deep, silicon-rich stellar layers, challenging standard supernova models.

SN 2021aefx: This exploded star challenges standard models because it shows an unusual early UV/optical "bump" and later nebular features, with no single existing model (like companion-shocking or double-detonation) fully explaining its early light curve and later spectrum, particularly the lack of hydrogen/helium emission despite strong nickel lines suggesting dense burning and pointing to deep flaws in conventional models. Predominantly, SN 2021aefx highlights that simple progenitor/explosion scenarios (like single white dwarf detonation) unable to explain the full range of early and late-time behavior observed. Instead of a consistent power-law increase, the u-band light curve grew strongly, then faltered before continuing, suggesting a rapid change in the ejecta's velocity and spectral features. Later observations revealed flux shifting into the infrared (IR) at a faster rate than predicted by standard models, requiring complex elemental distribution or ionization. Obviously, the observational data of SN 2021aefx point to asymmetric explosions and interactions that require fundamental revision of existing models to incorporate features like ejecta asymmetries and ionization processes.[32]



SN 2021aefx in NGC 1566 at ≈2–21 µm. Left panel: MIRI F1130W PHANGS-JWST image of NGC 1566 showing the location of SN 2021aefx, marked with a green circle. Right panels: zoom-ins on SN 2021aefx in each PHANGS-JWST filter. curves for SN 2021aefx in four photometric bands, plotted from data published by Hosseinzadeh et al.[33]

SN 2023ixf: The observational data of SN 2023ixf are identical to SU 2013fs. They are directly challenging theortical models by showing a delayed shock breakout and extreme mass loss, implying that giants stars lose much more material before reaching the stage of a complete destruction. Basically, the observational data are not what stellar evolution and CSM interaction theories for Type II supernovae are predicting. Specifically, the rapid rise of bright flash indicated dense circumstellar material (CSM) from recent, intense mass loss, disagreeing with simpler models and pointing to instabilities in its final stages. The initial light burst (shock breakout) was delayed by several days, which can only happen if the explosion shock encounters a dense shell of material, and the massive star has shed significantly more mass in its final years than what can standard models assume. Obviously, SN 2023ixf showed that massive stars can have rapid, eruptive mass loss events just before exploding, not just steady winds. Moreover, early spectra showed high ionization (like He II, C IV), indicating a very hot shock interacting with the dense CSM, and also the CSM density profile was much more compact than the expectation of the models.[34, 35]



The bright supernova SN 2023ixf in M101 'before and after' images captured by Paul Jacklin, 16 May and 20 May. Equipment: Canon T3i, Vintage C8 telescope with 6.3 reducer, Optolong L Pro filter. 150 x 120" stacked and edited. The rise and the decline brightness of SN 2023ixf.

SN 2024ggi: The evidence is continuing to amass, in 2024, the standard models of stellar explosion received another blow after the discovery of SN 2024ggi. It was initially detected by the European Southern Observatory's Very Large Telescope (VLT). Other telescopes, such as the Las Cumbres Observatory (LCO) 1.0 m, SOAR telescope, and Gemini-South telescope, also provided spectroscopic observations. Like all stellar explosions, the observational data revealed an olive-shaped, asymmetrical explosion of SN 2024ggi, not a spherical one, and its interaction with dense circumstellar material (CSM), indicating much higher mass-loss rates for red supergiants (RSGs) than what the conventional models are predicting. The spectropolarimetry data showed that the initial shockwave breakout of SN 2024ggi was elongated, not spherical, implying a non-uniform explosion. That is to say, the shockwave exhibited a well-defined symmetry axis (resembling an "olive" shape) that persisted through the ejection. Furthermore, the supernova's bright interaction with surrounding gas showed that the star shed mass at rates significantly higher than what Type II supernovae models are assuming, potentially pointing to a final "burst" of mass loss.

It is worth reminding, however, that progenitor stars are not fully confirmed, and according to current paradigm, that has to do with their extreme distances, obscuration by interstellar dust, and the relatively short, faint lifespans of some progenitor types. Moreover, it is assumed that many progenitors are entirely destroyed or obscured by dust produced during the explosion itself. Additionally, many progenitor stars are also thought to be massive, low-luminosity red supergiants that may skip a bright phase, or they could form black holes directly without a bright explosion. In the final analysis, the hypothetical progenitor (the theorized precursor) can only be fully confirmed when the supernova has faded enough to prove the progenitor star is gone. So, the observational data of SN 2024ggi, provided concrete data on the shape of the initial shockwave, and added, a new evidence of how these cosmic events are improperly interpreted.[36]

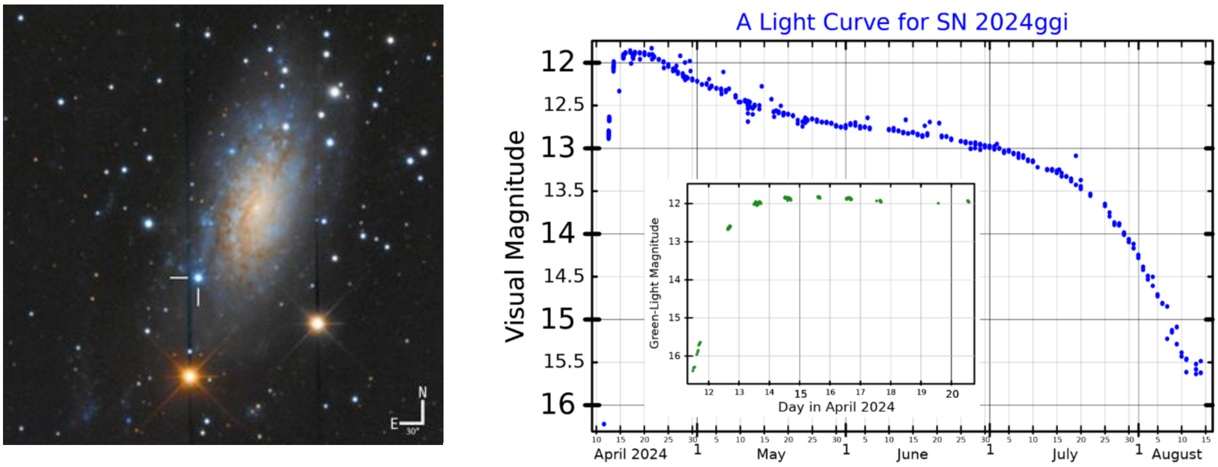
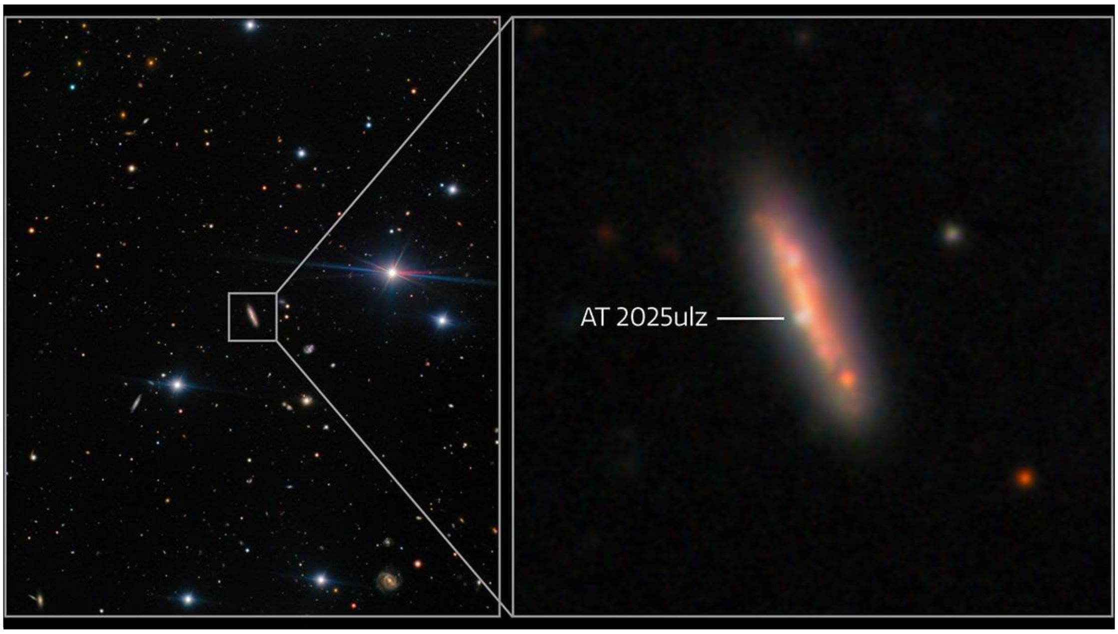


Image of the host galaxy NGC 3621 with SN 2024ggi (bright blue dot) being marked. A light curve for SN 2024ggi. The main plot shows the AAVSO data, and the inset plot, plotted from data published by Chen *et al.*, shows the first few days after the event.

AT2025ulz, was another remarkable exploded star that showed clear contradictions to conventional models. Its observed properties (luminosity, rapid onset, color) were difficult to reconcile with standard kilonova models. Initially, the transient was considered a potential kilonova, an astronomical event that supposed to be the result of a binary neutron star merger. However, several key observations did not fit the conventional kilonova scenario: The transient was about five times brighter in the g-band than AT2017gfo, the well-studied kilonova counterpart to GW170817. Its appearance occurred very quickly after the initial GW trigger, posing challenges for theoretical models. For instance, the Hubble Space Telescope (HST) observations revealed a color that was too blue for a kilonova, and the mass of the material ejected implied by the observations was uncomfortably large for the low mass of the GW candidate system. These discrepancies led researchers to conclude that the data instead support the classification of AT2025ulz as a stripped-envelope supernova, which initially underwent a shock-cooling phase. Nevertheless, this extremely powerful cosmic event (superkilonova), also shows the need to revise models of massive star collapse, neutron star formation, and binary evolution.[37]



Credit: Gemini Observatory

The Unexpected Shockwave: A shockwave around code-named star RXJ0528+2838, captured by the European Southern Observatory's Very Large Telescope (EOS's VLT) astounded observers. The shockwave extends around 3,800 times an Astronomical Unit, and the interaction with its environment deepened the puzzle. Astronomers never anticipated such an energetic outflow to occur, because traditional theory dictates that bow shocks around white dwarfs are caused by outflows from a surrounding accretion disk. In other words, white dwarfs need a material disk to fuel powerful outflows, but RXJ0528+2838 has none, yet generates a huge bow shock. However, this discovery like so many others directly challenges standard models of stellar evolution and shows the important role of external magnetic fields in stellar explosions. The research findings were published in Nature Astronomy in Jan 2026.[38]

This image on the left above from the Digitized Sky Survey (DSS) shows the region of the sky around the dead star RXJ0528+2838, which is located at the very centre of the image. (**Image credit:** ESO/Digitized Sky Survey 2. Acknowledgement: D. De Martin). The inset image on the right shows the dead star RXJ0528+2838 creating a shock wave as it moves through space. A strong outflow expelled from a star is usually the cause of such a shock wave. However, in the case of RXJ0528+2838, astronomers discovered that the shock wave can’t be explained by any known mechanism.**Credit:** Image via ESO / K. Ilkiewicz and S. Scaringi et al, PanSTARRS.[39]

Concluding Remarks

Empirical evidence has fundamentally contradicted the core predictions of current models of stellar explosions and consistently fails to align with them. These empirical data can be summarised as follows:

1- For decades, models depicted supernovas as nearly perfect spheres, but several recent discoveries have cracked this established theoretical framework. Overwhelming observational evidence show that all supernovae are fundamentally asymmetric rather than perfectly spherical, with core-collapse events often exhibiting strong bipolar, jet-like, or complex non-spherical geometries. These asymmetries are driven by magnetic fields and complex instabilities during the explosion, rather than interaction with surrounding material.

2- Researchers use highly complex 3D simulations that combine neutrino transport, hydrodynamics, and particle physics, but always these models work only in a theoretical sense, while real observations – such as the neutrino signals from SN 1987A – reveal gaps in understanding of the actual physical processes.

3- It is often difficult to clearly identify an observed supernova with its original star (the progenitor). Without this- before-and-after- comparison, theories about the conditions for an explosion remain partly speculative.

4- Observations of local Universe show a lack of high-mass progenitor stars (above 18 solar masses) for many supernovae, whereas standard theory predicts they should be common. This shows that massive stars can collapse into their cores without a complete explosion (without a bright, visible explosion).

5- New experimental data on isotopes like ^{60}Fe indicate that existing astrophysics models of massive stars are inconsistent with observational gamma-ray astronomy.

6- Recent high-precision analysis indicates that "all known Type Ia supernova models" fail to perfectly reproduce the observed luminosity-width correlation, a critical metric used to measure cosmic expansion.

7- Discoveries like SN 2021yfj show stars being "stripped to the bone" before exploding, revealing inner layers of silicon and sulfur that challenge standard onion-layer evolution models

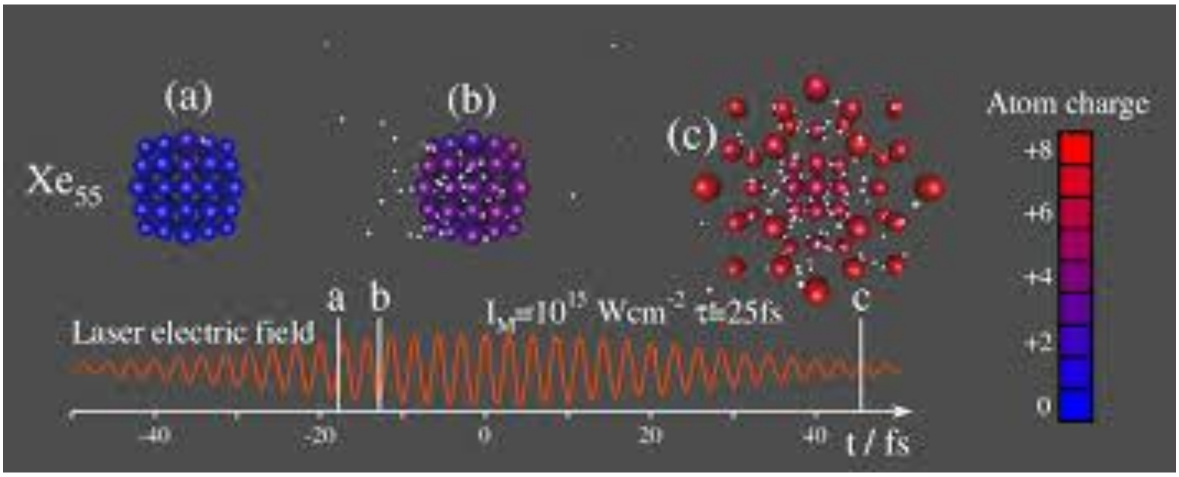
Thus, it is abundantly obvious that supernova theories are pure abstract and decoupled from empirical reality. This fact is increasingly recognized by most of institutional astrophysicists, although they are not acknowledging it publicly. At the same time, they are unable to provide the realistic physical models that represent stellar explosions.

PART TWO: THE PHYSICAL REALITY OF COSMIC EXPLOSIONS AND GALACTIC DYNAMICS

Introduction

Stellar explosions are often obscured by vast layers of stellar material making direct observation of the core extremely difficult. For this reason, current paradigm of stellar explosions is relying heavily on theoretical modeling, which often starts with simplified 1D models before progressing to complex 3D simulations. Nevertheless, evaluation of stellar explosions do not require sophisticated theoretical models and supercomputer simulations, if the physical reality of the stars is realized. That is to say, if a star is viewed as condensed matter entity surrounded by plasma layers with different densities, then it has to be considered as a unified-cluster, and its explosion can easily be explained with a well-known laboratory-induced phenomenon. Namely, all observed phenomena and features of "supernovae", including their brightness variations can be explained precisely by the mechanism of Atomic Scale Coulomb Explosion (ASCE). It is a mechanism by which a condensed matter system becomes a plasma through explosive disruption, rather than a process occurring within a pre-existing plasma, or rather a physical process that happens in systems bridging plasma and condensed matter, where the plasma from the condensed phase is initiated through rapid ionization and electrostatic repulsion. Essentially, the bridging process acts between condensed matter and plasma by converting ordered, condensed matter structures into ionized, high-energy plasma via rapid ionization. Calculating repulsive forces and resulting trajectories involves fundamental physics for simple, two-body interactions, and complex computational methods for multi-particle systems. The core approach utilizes Coulomb's law for force calculation, with Newton's Second Law dictating the movement of charged particles over time, often simulated using numerical integration methods like Euler or Verlet schemes.

However, the Coulombic Explosion of Stars (CES) always starts at the plasma-condensed matter phase or rather at the interface between them. When an intense ionization hits the outer layers including the very dense liquid surface, it strips away the electrons and negative ions from these layers that are composed of light elements mainly hydrogen and helium, leaving behind a highly positively charged, non-neutral, and unstable cluster. The surface tension will be broken, the surface area will be increased, and an explosive condensed matter reaction will be triggered. Basically, a star has to be considered as a condensed matter entity surrounded by plasma layers of different densities. That means, it can accurately be characterized as a closely unified-cluster of atoms, molecules, or ions. And, if it were heavily bombarded by an extreme electromagnetic radiation- depending on the distance and intensity of the radiation- the electrostatic repulsion among the star's constituents (atoms, ions and molecules) will cause an immediate, explosive rupture, and creating "hot spots" of plasma that expand into the entire surface. As a consequence, powerful shock waves will be induced and propogate with superluminal speed, because of the surface magnetic field which reaches an enormous strength. Note that, intense laser ionization of atomic clusters can enormously increase the surface magnetic field to GigaGauss (10^9 to 10^{10} Gs) range, which is comparable to the magnetic fields on the surface of a heavily dense star (or so-called neutron star). This phenomenon is driven by the interaction of ultra-intense (10^{21} to 10^{22} W/cm^2), short-pulse lasers with nanometer-sized clusters (e.g., gold or heavy atoms).



"The ionization and Coulomb explosion process, demonstrated for a small cluster (Xe_{55}, ion charges are color coded, electrons in light grey) irradiated by a 25 fs Gaussian laser pulse (peak intensity $I_M = 10^{15}$ Wcm^{-2}). (a) Initial tunnel ionizations, generating the first ion-electron pairs in the cluster, increasing the local electric field and facilitating further ionizations, (b) nanoplasma formation by classical barrier suppression and electron impact ionization, constituting the main inner ionization channels, (c) outer ionization and Coulomb explosion. The instants of the three snapshots of the time evolution together with the oscillating laser electric field are given on the time axis." **Credit:** Kimika Teorikoa Group.

So, an external magnetic field with high intensity leads to rapid and complete ionization, resulting in greater Coulombic repulsion and more energetic, luminous explosions. The stronger is the surface magnetic field, the faster is the propagation velocity and the higher is the brightness. In other words, a stronger surface magnetic field tends to drive more energetic plasma, resulting in faster propagation of MHD waves and higher brightness due to increased energy release, and even in the case of the Sun, stronger surface magnetic field corresponds to higher brightness during solar maximum.

Nevertheless, the ionization intensity, its duration and the material properties of the star are dictating how fast and how high is the rate of stripping off, thereby controlling the explosion's strength and the degree of fragmentation. Since, the outer layers of the stars are composed of plasma, during an intense ionization the electrons and negative ions are stripped off from their parent nuclei. With the electrons and negative ions gone, the positively charged nuclei become closely tied, increasing their mass per unit volume (increase in density) and strongly repel each other due to Coulomb's Law. The electrostatic repulsion accelerates the ions, causing the star to fragment partially or totally, depending on the ionization rate. A faster ionization rate leads to higher charge states (more electrons and negative ions removed), increasing the repulsive force significantly. The speed of ionization is governed by the field's peak intensity (stronger field $\Rightarrow$ faster ionization), and pulse duration plays an important role as well. Shorter electromagnetic pulses (EMPs) are stronger than longer, slower pulses or continuous wave radiation, they ionize more effectively before fragments fly apart. However, the duration of the pulses varies enormously, from fraction of a second to many years. This fact has been confirmed by recent astronomical findings, that showed pulses of energy emanating from stars with incredibly intense magnetic fields can indeed span a vast range of durations, from milliseconds to years, challenging previous, more rigid models of stellar behavior. For instance, research published in 2025 has identified FRB 20240114A as an exceptionally, and possibly the most, active repeating fast radio burst (FRB) source ever observed. Observations, primarily using the Five-hundred-meter Aperture Spherical

Telescope (FAST) and CHIME, revealed a sustained, high-energy, and highly periodic, or at least quasi-periodic, emission profile that challenges current magnetar models.

1- Pulse Peak Migration during the Outburst Decay of the Magnetar SGR 1830-0645: Crustal Motion and Magnetospheric Untwisting – IOP science.[40]

2- "The magnetar model's energy crisis for a prolific repeating fast radio burst source":[41] This key paper reports the 11,553 bursts detected by FAST and outlines the energy constraints on the magnetar model.

3- "A comprehensive search for Long and Short Periodic Characteristics in FRB 20240114A":[42] Identifies the 143.4-day periodicity and transient quasi-periodic oscillations.

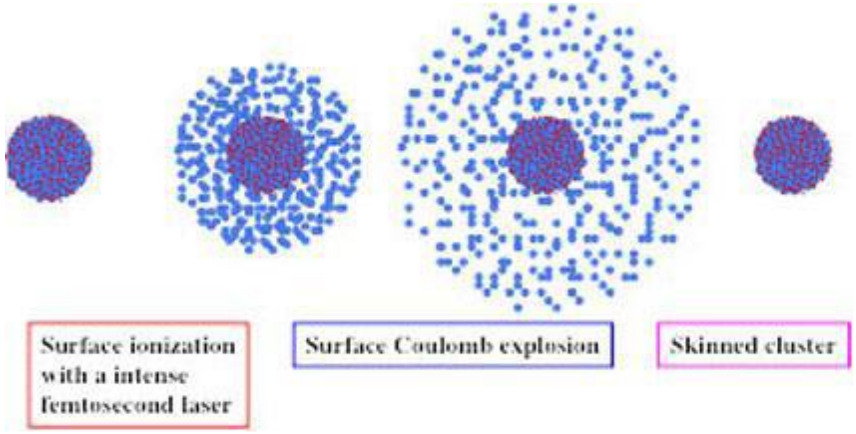
4- "The Host Galaxy of the Hyperactive Repeating FRB 20240114A":[43] Detailed optical spectroscopy of the dwarf galaxy hosting the FRB.

5- "A Hyperactive Fast Radio Burst Pinpointed in an SMC-like System":[44] European VLBI Network localization placing the source in a satellite galaxy.

6- "Searching for Periodicity in FRB 20240114A":[45] Investigates the burst-energy distribution and lack of short-term periodicity in specific, high-activity windows.

Another, invaluable observational study, and advanced 3D simulations confirmed that the traditional model — a spherical shock wave traveling directly outward — is an oversimplification, often replaced by complex, non-radial dynamics in the presence of dense circumstellar material (CSM) or asymmetric explosions. The study showed that Shock Breakout (SBO) can be significantly delayed or modified by dense CSM, with non-spherical, axisymmetrical shapes being common, as evidenced by recent spectropolarimetry of events like SN 2024ggi and SN 2023ugi. Moreover, the ionization potential of a star also plays a role; stars with lower ionization potential are easier to ionize, remember that stellar atmospheres, surfaces, and interiors exhibit significantly different ionization states and effective ionization potentials because of vast differences in temperature, density, and radiation fields. Also, while the intrinsic ionization potential of a specific atom is constant, the energy required to remove an electron in a stellar environment (ionization potential depression) and the resulting state of ionization change rapidly with depth.

Double Explosions of Atomic-Clusters: It is an explosive breakup of a multiply charged molecule or cluster that involves two or more distinct fragmentation steps. This phenomenon happens when a molecule first loses a neutral part and then the remaining ion explodes, or a highly charged ion splits into two large, charged fragments, driven by strong electrostatic repulsion. The molecule or cluster has to be ionised to a high charge state (e.g., +2, +3, +4) in order to cause the positive ions to repel each other violently due to electrostatic forces, leading to rapid fragmentation. However, most of the time the fragmentation isn't a single event, but involves sequential steps or parallel channels. A molecule first loses a neutral fragment, leaving a smaller, highly charged ion that then undergoes a Coulomb explosion. A Japanese research group showed experimentally the decisive role that the external electromagnetic radiation plays in the process of Coulomb explosion. The researchers used nanosecond pulse lasers, where a cluster (100,000 argon atoms) is thermally heated to a highly ionised plasma, expanded isothermally and adiabatically, and as a result, ions were emitted.[46] By using intense femtosecond lasers, the electrons were stripped spontaneously from the cluster, while the remaining part was exploded by the strong Coulomb repulsive force. Additionally, it was found for the first time that by adjusting the laser intensity, only the surface part of the clusters can be Coulomb exploded, leaving the inner core intact (the cluster can be skinned), see the figure below. This process is exactly identical to the Nova explosion, which involves only the removal or ejection of the outer envelope of a star, leaving the core intact (a non-destructive, surface-level event). The cause, has to do with the external ionization which does not exceed the threshold level or the level needed to induce a core explosion, and the reason a nova explosion triggers a massive, rapid increase in brightness is not related to thermonuclear reaction, but to the removal of the outer coordination sphere. A star is strongly coupled plasma-condensed matter entity and possessing a structure analogous to an outer coordination sphere. The removal of this outer structure will increase the brightness enormously. Actually, the situation is identical to the removal of the outer coordination sphere or protective layer of molecular-metal nanoclusters (such as gold or copper), which is a recognized method for significantly increasing their luminescence brightness.



Credit: Sakabe, S., Hashida, M., et al. Skinning of argon clusters by Coulomb explosion induced with an intense femtosecond laser pulse.[47]

Double Explosions of Stars: A double detonation of stars is supposed to be a specialized type of Type Ia supernova where a white dwarf, usually in a binary system, undergoes two consecutive explosions rather than one. Specifically, a white dwarf accumulates helium from a companion star, and this helium shell becomes unstable and detonates, creating a shockwave that travels inwards. The initial shockwave triggers a second, larger detonation in the core of the star. Yet, in reality, the double detonation of stars is identical to the two-step Coulomb explosion in atomic clusters, where molecules or clusters are ionised in stages – initially near equilibrium and later at critical distances – leading to highly energetic ion emission. The process involves a rapid, initial stripping of electrons followed by a second, stronger fragmentation phase caused by increased ionization rates at larger internuclear distances.[48, 49] It is a well-known, that atomic clusters can exist in metastable states, leading to sequential fragmentation. It is a multi-step, nonequilibrium process where a large condensed matter body breaks down through a cascade of successive, independent dissociations. Unlike concerted (simultaneous) breakup, sequential fragmentation occurs over a period of time, often involving the formation of a metastable intermediate. Experiments using pump-probe laser techniques have shown that initial ionization (first step) can be followed by a second, delayed ionization, leading to a second Coulomb explosion stage, particularly in complex dimers.[50] Molecules can also exist in metastable states in stellar and astrophysical environments. These are long-lived, high-energy states where molecular structures exist in a local minimum of potential energy but are not in their lowest possible energy state (ground state). Thus, the sequential fragmentation of stars resembles the one that happens in atomic clusters. In fact, recent astrophysical research indicates that stellar explosions can involve more than a simple double detonation. Studies, particularly those analyzing data from the SNR 0509-67.5 remnant, have shown that a white dwarf can undergo a dual explosion (double detonation) where a helium surface blast triggers a core explosion.[51] So basically, the outer layers of the star can undergo significant stretching and expansion during the initial phase of the bombardment, followed by further ionization and subsequent explosion, rather than a single simultaneous event. Definitely, this mechanism is widespread in stellar explosions, or rather, the most common, as many observations show.

Superluminous Stellar Explosions: The luminosity of exploded stars, particularly so-called (SLSNe), presents unsolved puzzle for conventional models. Type Ia supernovae are understood as "standard candles," yet recent observations of extraordinarily bright events have pushed these theoretical models to their obsolescence. That is because many exploded stars are far brighter than what standard, radioactively-powered models are predicting. Hence, astronomers had to invoke wild scenarios, such as rapidly spinning, highly magnetized neutron stars (magnetars) at the core of the explosion…etc. While magnetars and Circumstellar Medium (CSM) interaction are frequently cited in literature as theoretical mechanisms for powering superluminous supernovae (SLSNe) and other energetic transients by adding non-radioactive energy to the ejecta, evidence for these, particularly magnetar-driven energy, remains primarily inferential rather than direct. Moreover, some supernovae largely exceed the expected maximum brightness – like roughly 5 trillion times the Sun's brightness- achievable through standard radioactive decay of ^{56}Ni. On the other hand, the discovery of **ASASSN-15lh**, with a peak luminosity approximately equal to 2×10^{45} erg/s (nearly 100 times brighter than a typical supernova), severely contradicted existing theories and suggested energy-generating mechanisms far beyond the absolute magnitude of stars (standard luminosity models) and mainstream propositions. Actually, if another exploded star were observed to be significantly brighter than **ASASSN-15lh**, it would be an impossible task to find any theoretical concept to explain such an event, especially if one considered the gaseous star model to be a valid one.

Anyway, based on conventional models of stellar explosions, luminosity depends primarily on the amount of radioactive ^{56}Ni synthesized-ejected, the total energy of the explosion, and the mass of the ejected material. Yet in reality, the luminosity of stellar explosions is determined by electrostatic force, which is governed by the interaction of electric charges, where the strength of the force is heavily influenced by the magnitude of the charges (charge density) and the concentration of ions in the surrounding medium (ion number/density). These forces act according to Coulomb's Law, where higher charges and closer distances lead to stronger forces. The rate at which electrons become degenerate and expand through the mass (away from the ions) determines how quickly the net positive charge builds up, acting as a trigger, and the Coulomb potential of the separated positive charge (ions) must exceed the gravitational potential of the mass to trigger the explosion. That to say, the total energy released, and thus the intensity, is directly related to the magnitude of this separated charge. So, unlike the current view where luminosity is supposed to be governed by the energy release from the gravitational collapse itself (e.g., neutrinos, kinetic energy), in actual fact, the external magnetic field is the driver. It can lead to rapid and complete ionization, resulting in greater Coulombic repulsion and energetic explosions. And although, the rate of ionization determines how fast the charge builds up, the resulting charge density (q) and number of ions are the primary factors governing the degree of luminosity. In essence, the resulting explosion intensity (luminosity, pressure, and energy release) is primarily governed by the total amount of charge stored, the volume over which it is released, and the concentration of the ionized species. A higher charge density and more ions mean higher stored energy that would result in a more intense explosion, and higher luminosity.

Nevertheless, the physical process governing the brightness of the atomic-cluster explosions and the stellar explosions is fundamentally the same. In both cases, high-energy ions (positively charged nuclei) are produced, where the luminosity is characterized by the ion yield, and it depends mainly on the intensity of the external energy supply. Namely, with regards to, stellar explosion the luminosity depends on the intensity of electromagnetic radiation, while in the case of the atomic-cluster explosion it depends on the intensity of the laser, which is directly related to the velocity of particles. Note that, cosmic particles can indeed be accelerated to superluminal velocities within the intense, turbulent electromagnetic fields associated with extremely dense stars. What is more, the acceleration of particles at the cores of some galaxies can reach far higher velocities than those affiliated with immensely dense stars. The centers of active galaxies—specifically Active Galactic Nuclei (AGN) or quasars—are generally brighter and far more persistent than superluminous supernovae (SLSNe), and they maintain this brightness over much longer periods.[52, 53] However, the extreme luminosity at the cores of these galaxies, comes from synchrotron radiation, as a result of super-acceleration of cosmic charged particles by the super-strong magnetic fields, not by supermassive black holes. In other words, although, the high concentration of stars in the galactic bulge (which can be millions of times denser than our solar neighborhood) is a factor contributing to the extreme brightness of galactic centers—particularly in active galaxies—the main reason is the super-intense magnetic fields at those regions. Those fields accelerate high-energy charged particles to high energies and superluminal velocities, primarily by manipulating their trajectories and facilitating energy gain through associated electric fields. The situation is identical in the atomic-cluster explosion, where the velocity of particles increases rapidly due to the massive electrostatic repulsion between positively charged ions following the sudden removal of electrons, triggered by an intense laser field. The atomic-cluster explosion accelerates charged particles (typically ions) to MeV- energies range via intense, repulsive electrostatic forces that occur when a dense cluster or target loses most of its electrons, leaving a highly ionized positive space charge. Note that, a highly ionized positive space charge, particularly when moving at high speeds, possesses or generates an extremely strong magnetic field. Thus, electromagnetic interactions play the dominant role in the process of rapid, explosive expansion, specifically by mediating the conversion of stored internal potential into kinetic energy and thermal radiation, resulting in directed ion beams, which are extremely bright, high-intensity, and often highly collimated, making them valuable tools for advanced imaging and material processing. As, we already know, this phenomenon occurs when an intense laser pulse strips multiple electrons from atoms or clusters, causing the remaining positively charged ions to repel each other violently, resulting in a high-flux, high-energy ion beam.

Failed Stellar Explosion: As already stated, in all types of stars the explosion initiates in the outer layers, creating a shock wave that blasts into the core, but in case of unsuccessfuil explosion, the core is not impacted, just the outer layers collapse or fall back into the core without causing it to explode. The ionization of the surface of a star generally leads to an increase in the density of its core, particularly during the initial stages of interaction with an intense, short-pulses of electromagnetic radiation. Besides that, the unsuccessful explosions take place exclusively in massive stars. typically those with initial masses greater than ~8–10 solar masses, and often observed in red supergiants around 17–25 solar masses. For example, based on recent studies, M31-2014-DS1 was a massive star located in the Andromeda galaxy (M31) that failed to explode. The star was estimated to be roughly 13 to 20 times the mass of the Sun. Before its core collapse and disappearance, the star had shed significant material, with estimates placing its remaining mass around 5 to 6.7 times that of the Sun. The star began a sustained, dramatic fading in 2016, becoming undetectable in optical and near-infrared light by 2023.[54] There has been one other instance of a star mysteriously disappearing, a failed supernova candidate dubbed N6946-BH1 that underwent an outburst in 2009 and has since disappeared in the optical, according to a 2021 paper.[55] But, given the even longer distances involved, plenty of questions remained unanswered.

However, those stars that fail to explode, possess incredibly massive dense cores and extremely powerful internal magnetic fields to start with. They require an immense, catastrophic trigger to initiate their explosion, and the energy for this trigger does not come from gravity, but from an external magnetic field. If the intensity of the external magnetic field is not strong enough, or the star is colossal and possesses huge core density, it will not reach the high charged state required for an explosive, total breakup. But, rather remains stable or partially stable than breaking apart,- the process is similiar to, a failed coulombic explosion of atomic clusters – the electrons are detached from atoms in the outer shells (atmospheres) of stars due to intense ionization, driven by high-energy electromagnetic radiation, and this mechanism transforms the stellar gas/liquid layer into a high-temperature dense plasma. Yet, if the ionization energy supplied to the star is not strong enough, the detached electrons will fail to gain enough kinetic energy to escape, and consequently recaptured by the positive fragments, leading to neutral, excited atoms rather than charged fragments. In other words, if the electrons are not completely removed, they can oscillate back and forth through the positively charged core, and the resulting electrostatic forces lead to the core collapsing under its own positive charge, rather than expanding. Also, one can describe the process in a different way, namely that when the electrostatic repulsive energy generated by intense ionization is insufficient to overcome the binding forces of the star's materials, that will cause the outer layers to collapse or fall back onto the highly charged core rather than dispersing. Basically, a failed stellar explosion turns into an implosion, where ions are pulled toward the dense positive center, instead of flying outward.

In summary, a failed stellar expolsion is absolutely identical to a failed atomic-cluster explosion. It is a situation where an intense energy input, like a laser tries to shatter a molecule or solid cluster by ejecting electrons, but the positive charge left behind is not strong enough or long-lasting enough to overcome the electrostatic attraction of the core, causing the system to remain bound or undergo thermal melting rather than exploding. This happens when the laser intensity is too low to completely ionize the system or break the atomic bonds, preventing a violent, explosive rupture. Note that, breaking the atomic bonds of highly dense object is indeed exceptionally difficult, often requiring immense energy. This difficulty stems from the fundamental relationship between density, bond strength, and the energy required to overcome the electrostatic forces holding atoms together. For instance, breaking the atomic bonds of a highly dense core, such as those found in a highly-magnetised, ultra-dense stars, is extremely difficult because these structures are held together by forces that are vastly stronger than those in everyday matter. Recent research using asteroseismology has detected strong magnetic fields (30 to 100 kilogauss) in the cores of red giant stars.[55] In these environments, ordinary atomic, covalent, or ionic bonds have ceased to exist, replaced by strong nuclear force interactions that are 10^{38} times stronger than gravity. Anyway, in a failed atomic-cluster explosion, electron-phonon coupling transfers energy into heat instead of instant separation. The remaining positive charges on the core are insufficient to overpower the bonding attraction to the outer electron shells/ions. The structure doesn't fly apart; it typically melts or turns into a plasma, where the ions and electrons are still within the influence of the central potential. Basically, the cluster or molecule experiences thermal ablation melting rather than a Coulomb explosion (shattering), as the cohesive forces attraction of the core remain stronger. Note that, a failed or frustrated Coulombic explosion of atomic clusters is an extremely fast, non-radiative decay process that typically happens on a femtosecond time scale, often within 10 to 100 femtoseconds, with some processes occurring even faster, such as within a few femtoseconds (1–5 fs for initial ionization). The situation is identical in the case of a failed stellar expolsion, where the quiet collapse happens remarkably fast. The initial collapse with the core implosion occurring in just a few seconds, unlike a typical, bright explosion that happens over weeks or months.

Factors Determining the Degree of Fragmentation in Coulomb Explosions: Both types of Coulombic explosions (the atomic-cluster type and the stellar one), depend mainly on the rate of external ionization, and to a certain extent on the molecular and chemical composition. When a star absorbs a high rate of ionization, – *but not an extremely intense one and not in a short time scale* - for a long duration, it loses its outer layers gradually, while the density of its exposed core increases significantly. The removal of the outer envelopes of a star and its explosion at later stage of ionization, which can vary from months to hundreds of years or even more, is not related to its life cycle. As a matter of fact, it is frequently being observed that 'supernovae' can indeed occur in relatively young, low-mass (not reaching the 8-solar-mass threshold), or intermediate-mass stellar populations, contradicting the traditional view that only extremely massive, young stars (Type II) or very old, low-mass stars (Type Ia) explode.[56, 57] However, the process of star ionization and explosion is identical to the process of atomic-cluster ionization and explosion. Literally, both processes are governed by the same underlying physical principles, demonstrating the universality of the fundamental law of nature and its manifestations. For instance, the degree of fragmentation in atomic-cluster explosions is determined by the intensity of the driving field, the ionization rate, and the molecular structure, and these requirements are identical to those that determined the degree of fragmentation of stellar explosions. Specifically, high-intensity, ultrashort pulses often lead to complete or near-complete dissociation, reducing molecules into their constituent atomic ions. At intensities $\geq 10^{15}$ W/cm^2 , the laser's electric field becomes comparable to or exceeds the internal atomic fields binding the electrons. This triggers barrier-suppression ionization (BSI), where electrons are no longer confined by a potential barrier. The peak intensity determines the maximum charge state Z achieved by the atomic constituents. According to Coulomb's Law, the repulsive force F between two ions with charges Z_1 and Z_2 is $F = k\, Z_1Z_2/r^2$. As intensity increases, Z increases, leading to higher kinetic energy release (KER) and more complete fragmentation. So, when subjected to intense femtosecond laser pulses, the molecule's structure influences the charge distribution, leading to specific, often anisotropic, fragmentation. Besides, the decisive factor of external ionization, the type of molecule, including its geometric structure, atomic composition, and bond strength, also play roles in determining the dynamics and fragmentation patterns of atomic-cluster explosion. Molecules with smaller r values store more potential energy upon ionization, leading to more energetic explosions. Also, the spatial orientation of the molecule relative to the laser's polarization axis influences the ionization efficiency, due to the enhanced ionization effect at critical internuclear distances, while the molecular structure dictates the initial inter-nuclear distance r. because, the potential energy U is inversely proportional to the distance:

$$U = \frac{1}{4\pi\varepsilon_o}\sum\frac{q_i q_j}{r_{ij}} \quad i < j$$

The degree of fragmentation depends heavily on the competition between the ionization rate, the nuclear motion timescale and larger molecules, such as butane which can exhibit a wide variety of fragments. Also, the ultrafast pulses (≤ 100 fs) are necessary to induce true and effective explosion before the ions have time to move considerably. When a laser pulse is significantly shorter than the vibrational period of a molecule (typically in the femtosecond or attosecond range), it interacts with the system faster than the nuclei can respond, and the intense field removes multiple electrons nearly instantaneously. That is because the nuclei are much heavier than electrons, and they remain effectively stationary during this brief ionization phase. Once the stabilizing electrons are gone, the remaining positively charged nuclei experience intense Coulombic repulsion, and since they are still in their original equilibrium geometry, they "explode" outward.

The Asymmetric Feature of Coulomb Explosions: The explosions of molecules/clusters and explosions of stars are both characterized by asymmetric feature. In case of atomic-cluster explosion, an intense laser field is a primary driver of the phenomenon. It causes asymmetric charge distribution, with higher ionization occurring at the poles aligned with the laser polarization, leading to faster, more energetic ion expansion along that direction. The external electromagnetic field, breaks the spherical symmetry of a cluster's ionic background, forcing faster expansion along the polarization axis and resulting in anisotropic ion energy distributions. The asymmetry is caused mainly by the electric field component of the laser, which acts along the polarization direction. In other words, the intense, oscillating electric field of the laser preferentially ionizes electrons along the direction of its polarization and drives electrons away from the ionic core, creating an asymmetric charge distribution immediately after ionization. And, the field continues to influence the ions as they fly apart, causing further asymmetric charge redistribution or potential deformation. As, a result, ions at the ends of a cluster (along the polarization axis) become more charged than those in the center, leading to faster, asymmetric expansion along that axis. For short pulses, the laser field creates an asymmetry in the electron dynamics themselves, even without collisions. Basically, the intense electric field of the laser breaks the spherical symmetry of the molecule/cluster by causing preferential ionization along the polarization axis, leading to a faster and more intense Coulomb repulsion in that specific direction, resulting in an asymmetric explosion.

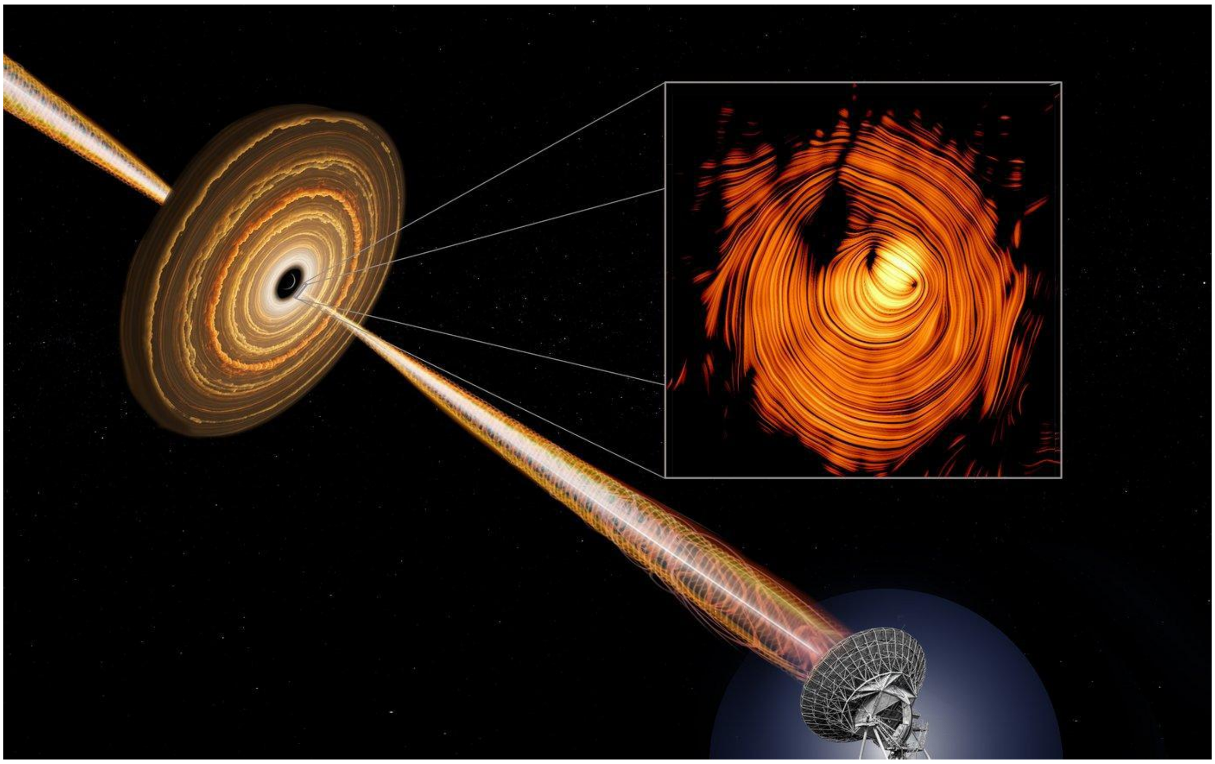
However, standard models of stellar explosions are assuming a uniform, spherical explosion. Yet, an extensive amount of empirical evidence from modern astronomy confirms that the geometry of stellar explosions are indeed asymmetric. Techniques like spectral polarimetry have shown that these events are lopsided, with debris ejected unevenly in different directions. For instance, recent, real-time observations of exploded stars, such as SN 2024ggi, have revealed that the exploding shockwave emerges in an elongated shape, akin to a flattened "olive," rather than a perfect circle. SN 1987A: A well-studied, iconic example, shows significant asymmetry in its inner ejecta, expanding faster in some directions than others. Moreover, an observational analysis of SN 2010jl showed that light from the explosion was heavily polarized, indicating a strongly asymmetric shape. And, data from the Palomar Observatory showed that SN 2018hna exploded in an elliptical shape, while recent, nearby explosion of 2023ugi revealed an "olive-shaped" (prolate) asymmetry, suggesting a non-spherical, jet-like breakout. Also, observations of the radioactive isotope Titanium-44 in "supernova remnants", most notably Cassiopeia A (Cas A), have provided crucial insights into the explosion mechanism of this star. Titanium-44 is distributed in a highly non-uniform, clumpy, and asymmetric manner. Furthermore, and most importantly, the above observations are not the only asymmetric explosions, all stellar explosions are fundamentally asymmetric, yet this Universal fact is not accepted explicitly.

The Olive-Shaped Explosion: Most, if not all stellar explosions are characterized by lopsided, non-spherical, and often olive-shaped geometries, with substantial material ejected in specific directions, including the so-called Type Ia supernova. In fact, up to date studies have confirmed that stellar explosions are indeed lopsided, non-spherical, and often olive-shaped. Most importantly, the shockwave breaking through the star's surface,- from outside rather than from inside out – and does not expand uniformly, but rather in a directed, axis-symmetric manner, flinging significant material in particular directions. For instance, recent groundbreaking observations of supernova SN 2024ggi, captured just 26 hours after detection by the Very Large Telescope (VLT), revealed a distinct "olive-shaped" blast. Instead of a spherical expansion, the material from the exploding star (a red supergiant with 12 to 15 solar masses) was initially shaped like an olive, and became flatter or more complex, consistently demonstrated high asymmetry at the earliest stages of the breakout. Another observational evidence, could be seen in data from NASA's NuSTAR telescope[58] regarding Supernova 1987A, which mapped radioactive titanium-44, and provided a "smoking gun" by showing that the explosion engine is lopsided, sending material moving away in one direction at immense speeds (approx. 1.6 million mph). These findings are crucial, as they show that the lopsided nature of stellar explosions is a fundamental characteristic in the destruction of massive stars. Apparently, the reason for asymmetric stellar explosions- and just like in the case of atomic-cluster explosion- is caused, mainly by an external, intense electromagnetic field. The uneven, direction-dependent redistribution of electrons during the coulomb fragmentation process of a cluster, is driven by external fields (e.g., laser pulses) or collision dynamics. As electrons are ejected or localized toward one side, the resulting unbalanced charge distribution leads to stronger, preferential ion acceleration in one direction rather than an isotropic explosion.

The Role of External Pressure in the Formation of Olive-Shaped Geometries: The external pressure is a primary driver in the formation of prolate (olive-shaped, elongated) ellipsoidal geometries, acting as a sculptor that determines shape based on stress distribution and structural resistance. This phenomenon occurs across diverse physical entities, from engineered pressure vessels and geological formations to biological membranes and particulate matter. For instance, an external pressure would cause an "olive-shaped" explosion, often seen in confined spaces like buildings with vents, as the blast wave is shaped by the constraints of the vent and the surrounding environment, creating an elongated (oval/olive-like) pressure field instead of a perfect sphere, with gas rapidly escaping and causing intense, directed combustion and an attenuation load, as gas density changes significantly after venting. This phenomenon involves rapid gas release and combustion, where the initial spherical shockwave becomes distorted by the vent's geometry, leading to a characteristic elongated pressure distribution that propagates outward. Obviously, an external pressure such as that experienced by an evacuated vessel, can cause it to collapse into an "olive-shaped" (elongated along one axis) configuration. Furthermore, the external pressure induced by a magnetic field can indeed be enormous, often referred to as magnetic pressure (P_m), which is defined by the formula $P_m = B^2/2\mu_o$. In many astrophysical contexts, this is often expressed in CGS units as: $P_m = B^2/8\pi$. Because this pressure increases with the square of the magnetic field strength B, even relatively modest fields can produce significant forces, while extremely strong magnetic fields, such as those found in highly dense stars or so-called magnetars can induce colossal pressure ($>10^9$ Gauss).

Beamed Astrophysical Energy Sources and the Destruction of Stars: Beamed astrophysical energy sources (astrophysical jets) are high-energy, collimated emissions of radiation and particles from enormously dense and fast spinning astronomical entities, driven by extremely intense magnetic fields.

accessible



Looking inside the plasma jet cone of the blazar PKS 1424+240 with a radio telescope of the Very Long Baseline Array (VLBA).[59]

These ultra-fast jets can span millions of parsecs, and their primary function is transporting enormous amounts of energy, from the central engines of galaxies, especially active galaxies (AGN) into the surrounding interstellar medium and often outside the boundaries of their host galaxies (acting as conduits that channel magnetic flux and energy over vast astronomical distances). They are the most violent and energetic explosions in the universe, with the capability of destroying stars or fundamentally disrupt their structure in a very short time frame, sometimes lasting only a few seconds to a few minutes. These highly energetic jets represent a transition from slow stellar destruction caused by low intensity radiation into nearly instantaneous one, where a stellar entity is incapacitated or shattered within moments, rather than thousands or millions of years. The strongest astrophysical jets are produced by the most intense magnetic fields of the most dense cosmic entities, such as the center of active galaxies, quasars, radio galaxies and by immensely dense, tiny stars. These jets are travelling with super-speed, frequently exceeding the so-called universal speed limit, and stretching for thousands of light-years or even millions of light-years, far beyond the host galaxy itself, especially when the initial velocity is superluminal. Like in the case, of a well-studied jet from the center of the M87 galaxy, which extends to 3,000 light-years, or in the case of the massive jets from Porphyrion radio galaxy which are exceptionally long spanning, roughly 23 million light-years (7 megaparsecs) or 140 Milky Way galaxies.

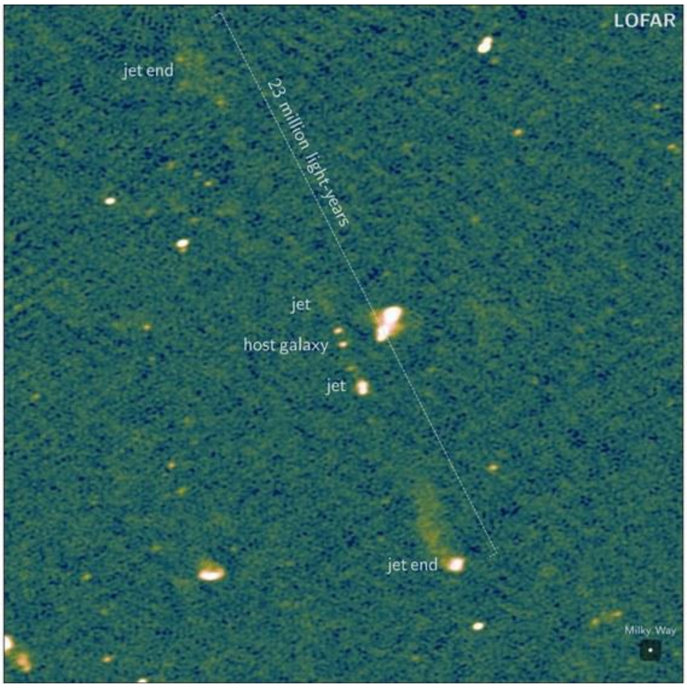


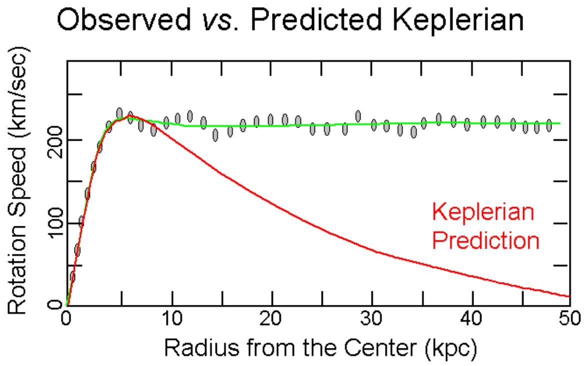
Image from the LOFAR radio telescope: This image, taken by the European LOFAR (LOw Frequency ARray) radio telescope, shows the longest known jet pair from a black hole. Co-discoverer Aivin Gast from the University of Oxford named the two plasma jets after the giant Porphyrion from Greek mythology. They extend over 23 million light years, which corresponds to the size of 140 Milky Way galaxies in a row. The galaxy that harbours the supermassive black hole can be seen as a dot in the centre of the image. The largest blob-like structure near the centre is another smaller jet system.[60, 61]

Apparently, it is not unreasonable to consider astrophysical jets as cosmic cannons, because they exhibit behaviors that resemble the motion of projectiles, but with significant superluminal initial velocity, magnetic, and hydrodynamic complexities, the mechanism goes far beyond simple gravity-driven trajectories. The higher is the initial velocity of the jet, the farther is the extended distance, particularly in space environment where the horizontal range of a jet increases with the square of the initial velocity. Note that, by assuming negligible air resistance the extension of a projectile–specifically its maximum horizontal range and maximum height – depends directly on the magnitude and direction (angle) of the initial velocity. The same principle is valid in the case of astrophysical jets, namely, these jets would not extend to such great distances if their initial velocities were not far higher than the so-called universal speed limit. For example, the collimated jet from the center of Messier 87 (M87) is actually traveling 6.3 times faster than *c*, but current physics paradigm is considering this superluminal motion as an optical illusion (only an apparent superluminal motion) not a real one. The term optical illusion is supposed to occur when an object moves at speed approaching the speed of light (the so-called Terrell-Penrose effect). Yet, the effect relies on specific operational definitions of simultaneity, implying it does not represent the absolute visual reality for all observers.[62] The misuse/misinterpretation of the optical illusion is widespread in quantum mechanics and astrophysics. For instance, the Sun's surface is considered as an optical illusion (optical surface), rather than a real surface. On the other hand, the wrong involvement of optical illusion in atomic-subatomic physics is the root cause for some of the deepest defects. Namely, the optical illusion in quantum theory creates a false or illusionary picture of reality by focusing on mathematical probability rather than on an underlying, deterministic, physical reality. The current notion that assumes particles exist in two places at once is not a true nature of reality, but rather a consequence of a flawed, observer-dependent framework (quantum superposition is not a real physical phenomenon). However, one might say that quantum theory is a correct mathematical model that provides incorrect physical interpretations of what is actually happening at the deepest level, beacuse there is no consensus on what quantum equations actually tell us about the nature of reality. That means, in the final analysis, quantum theory is a mathematical tool for predicting random events, but without describing the underlying physical reality or mechanisms that cause those events. It is a tool for predicting probabilistic physical events, but it does not tell us what is there in any intuitive way, leading to the conclusion that its physical interpretations are simply placeholders for a deeper reality. Basically, the dependency on the observer creates a false sense of fundamental randomness, whereas a deeper superdeterministic model of reality exists, and it is linked with the magnetic nature of matter. Recent breakthroughs in materials science have unveiled that magnetic properties are not merely superficial characteristics of matter, but are deeply and foundationally linked to the atomic, and topological structure of reality.[63] The scientific community must discard core assumptions and return to deterministic, classical models, with the magnetic structure of matter as a fundamental framework. Reliance on quantum theory is a serious hurdle for obtaining scientific breakthroughs and achieving great scientific progress.

However, observations on galactic and extra-galactic scales, show that magnetic fields are ubiquitous throughout the Universe, acting as a crucial, largest-scale force that connects galactic cores to the wider cosmos. Far from being just local phenomena (like planetary or stellar fields), magnetism is intrinsically linked to galactic structure, shaping the evolution of interstellar gas, star formation, and the propagation of all types of cosmic radiations on scale of billions of light-years. Furthermore, and most importantly, galactic cores have to be considered as the most powerful electromagnet-like structures, operating on a colossal scale, manipulating matter and energy. The center of a galaxy acts as a massive, magnetic dynamo that converts kinetic energy from rapidly swirling cosmic material into a powerful, organized magnetic field. Just as an artificial electromagnet uses electric current flowing through a coil to produce magnetism, the galactic core uses the motion of ionized plasma in its accretion disk to generate magnetic fields that are strong enough to shape, drive, and even channel the surrounding material. And, this proposed notion that galactic cores behave as an extremely powerful magentic dynamos is supported by many galactic, extra-galactic observations. For instance, although Sagittarius A* is not a traditional electromagnet made of wire, it functions as a large-scale galactic dynamo, where the rotating charged particles within the dense cosmic materials create, amplify, and sustain massive magnetic fields. As a matter of fact, the evidence of the nature of galactic core's electromagnetism can be seen in many observations. First of all, Sagittarius A* is spinning at an incredible speed, in spite of its size and density.[64] That is a sufficient evidence for the mind-boggling intensity of its magnetic field, because any dense, fast-rotating astronomical entity possesses extremely powerful magnetic field, and this obvious fact, or rather the fundamental rule applies to all galactic cores, and not only to the tiny dense stars (the so-called neutron stars). Moreover, strong-attractive magnetic zones with extremely high magnetic flux densities exist around the cores of galaxies, where all physical objects are subjected to powerful, immediate, and irreversible pulling forces. The existence of these zones has recently been confirmed by Atacama Large Millimeter/submillimeter Array (ALMA) and the Stratospheric Observatory for Infrared Astronomy (SOFIA).[65] Also, observations from the Event Horizon Telescope (EHT), as well as near-infrared and radio measurements have confirmed that strong, ordered, and structured magnetic fields spiral from the edge of Sagittarius A*.[66] As the cosmic material spirals inward, it becomes heavily magnetized and acting as a magnetized conductor that converts rotational energy into magnetic energy, influencing greatly the behavior of the plasma around it. Essentially, the central magnetic field of a galaxy is working as a dual particle accelerator, accelerating cosmic material inward and outward identical to, the Sun's magnetic field which acts as a dual accelerator, by simultaneously pushing emitted solar radiation (plasma) outward (the solar wind) while accelerating cosmic radiation toward the solar surface. In fact, this feature applies to the magnetic fields of other astronomical bodies and celestial objects, including Earth's magnetosphere which can accelerate particles inward and outward, acting also, as an energy accelerator. Definitely, these powerful magnetic fields at the centers of galaxies are responsible for driving powerful, galaxy-scale outflows or jets, that play crucial roles in the large scale energy transport across the entire universe, and also in heating of the surrounding interstellar medium through the process of electromagnetic induction (eddy current).

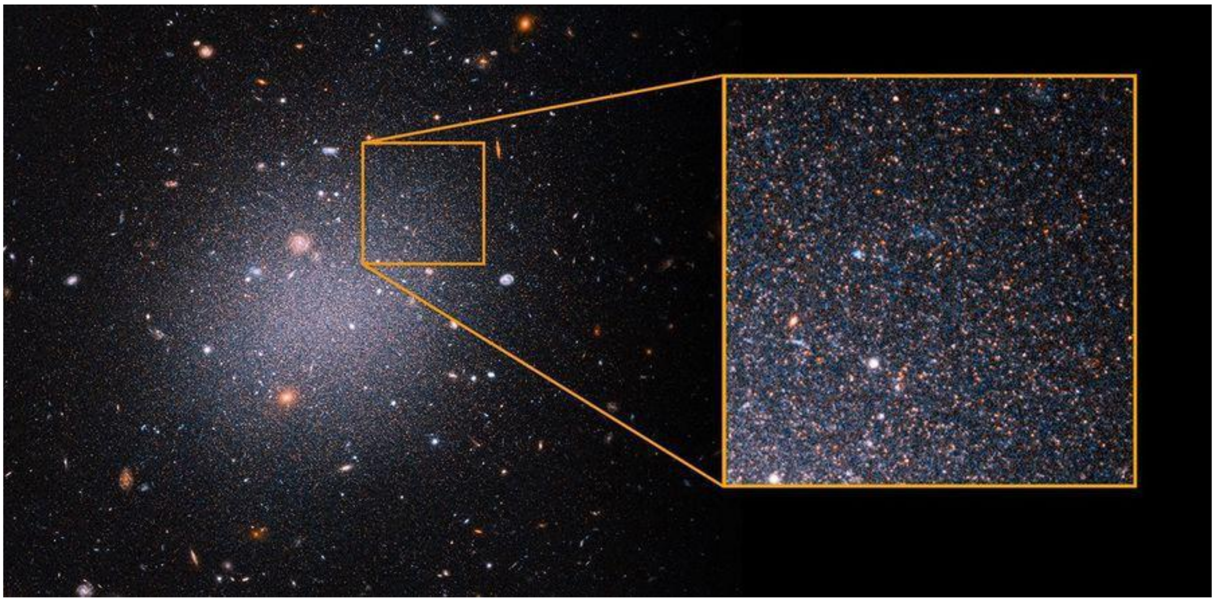
GALACTIC DYNAMICS

The Flat Rotation Curves of Galaxies and the Defiency of Hypothetical Dark Matter: The flat rotation curves are not a universal phenomenon across all types of galaxies, but they are restricted to the fast-rotating galaxies, and these curves are more pronounced in the fast rotating disk-shaped spiral galaxies, especially super spirals ones. On the other hand, observations show that elliptical galaxies, dwarf galaxies, low-surface-brightness galaxies, and many massive galaxies at high redshift exhibit declining or non-flat rotation curves. These galaxies do not have a uniform, high-speed rotational motion; their stars instead orbit the center in random, chaotic directions. That means, the rotation curve phenomenon is exclusively proportional to the rotational speed. That is to say, a faster galaxy rotation corresponds to higher orbital velocities, which create a more pronounced, flatter rotation curve.



Credit: R. Pogge:[67] The observations show that the rotation speed stays roughly constant (a "flat rotation curve") at large radii!

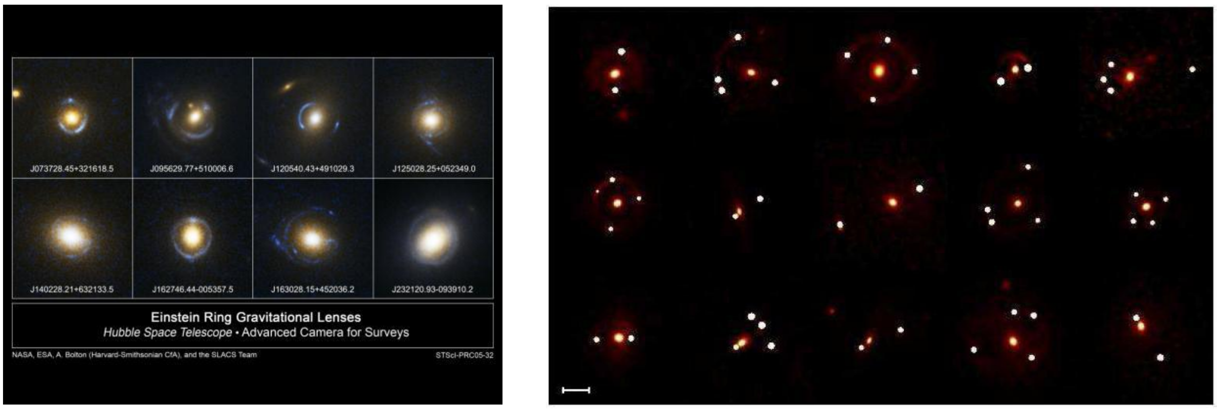
Recent discoveries, particularly of galaxies like NGC 1052-DF2 and NGC 1052-DF4, have challenged the standard model that assumes almost all known galaxies are embedded in large dark matter halos. In 2018, a team of astrophysicists led by Pieter van Dokkum, an astrophysicist at Yale University, showed that the average speed of globular clusters in galaxy NGC 1052–DF2[68] matched a baryons-only galaxy model, though many astrophysicists did not want to accept the result, and pushed for the removal of the research article. Despite the controversy, the initial 2018 study was not retracted, and further studies, including those using HST and JWST, have continued to support the existence of these "dark matter-free" galaxies.



"This Hubble Space Telescope image offers a sampling of aging, red stars in the ultra-diffuse galaxy NGC 1052-DF2, or DF2. The galaxy continues to puzzle astronomers because it is lacking dark matter, an invisible form of matter that provides the gravitational glue to hold galaxies together. Precisely establishing the galaxy's distance form Earth is a step toward solving the mystery. The close-up at right reveals the many aging red giant stars on the outskirts of the galaxy that are used as intergalactic milepost markers. Researchers calculated a more accurate distance to DF2 by using Hubble to observe about 5,400 red giants. These older stars all reach the same peak brightness, so they are reliable yardsticks to measure distances to galaxies. The research team estimates that DF2 is 72 million light-years from Earth. They say the distance measurement solidifies their claim that DF2 lacks dark matter. The galaxy contains at most 1/400th the amount of dark matter that the astronomers had expected, based on theory and observations of many other galaxies. Called an ultra-diffuse galaxy, the galactic oddball is almost as wide as the Milky Way, but it contains only 1/200th the number of stars as our galaxy. The ghostly galaxy doesn't appear to have a noticeable central region, spiral arms, or a disk. The observations were taken between December 2020 and March 2021 with Hubble's Advanced Camera for Surveys." **Credits:** SCIENCE: NASA, ESA, STScI, Zili Shen (Yale), Pieter van Dokkum (Yale), Shany Danieli (IAS) IMAGE PROCESSING: Alyssa Pagan (STScI).

These findings are significant and very serious challenge, because dark matter is thought to be the "invisible glue" (constituting ~85% of matter) that holds galaxies together, acting as a structural requirement. Yet**,** NGC 1052-DF2 was found to have ~ 400 times less "dark matter" than expected, a finding further confirmed with more robust data. And, in 2019, nineteen galaxies discovered that were missing the invisible gluing matter, and hardcore mainstream astrophysicists were unhappy with the discovery but unable to provide a convincing reason.[69] These galaxies comprise the longest list of galaxies lacking the magic matter, but they weren't the first or the last. For instance, recently six slow-rotating spiral galaxies showed significant deficiency.[70] They exhibit dynamical-to-baryonic mass ratios near 1.09, indicating their rotation is supported almost entirely by visible matter, challenging standard galaxy formation theories, and exhibited the decisive role of the rotational speed in the phenomenon of rotation curve. Furthermore, a recent finding has identified massive, highly mature galaxies in the so-called early Universe (redshift z ≈ 7-10) that are far more developed than expected, as well as specific local galaxies with little to no dark matter. By, using integral field spectroscopy of JWST, researchers found that the dynamics (velocity dispersion and rotation) of galaxy NGC 1277 (lenticular galaxy) can be explained solely by its stellar content, suggesting little to no dark matter is present.[71, 72] Another, study that was carried out much earlier (in 2013), involved gravitational lensing images from the Hubble Space Telescope, measured the mass-to-light ratio of 15 elliptical galaxies, and found it to be constant for different sizes of Einstein rings. The researchers measured an average mass-to-light ratio of 1.8, meaning that there is almost twice as much mass present as would theoreticians expect based on the amount of light. That means these galaxies do not have a rotation curve problem similar to fast spiral galaxies, and their stellar kinematics and velocity dispersion profiles can be explained without the existence of dark matter.

These observed galaxies by HST and JWST are remarkably massive and luminous, suggesting a much faster, more efficient star formation process than the gradual growth predicted by ΛCDM. Evidently, these observations that span for many years, contradict the standard ΛCDM paradigm that dictates massive galaxies are dominated by dark matter. On the other hand, dwarf galaxies, the most common type of galaxy in the universe, - in some galactic clusters, dwarf galaxies constitute roughly 70-90% of the population- are considered as the most dominated dark matter systems, but this view is not supported by observational data.[73]



Gravitational lensing from the Hubble Space Telescope images of the 15 galaxies observed in the article. The white dots are the quasar images. Eight galaxies produced 4 quasar images, while seven were more misaligned and only produced 2.[74-77]

Conclusively speaking, these empirical data have shattered not only the foundations of the long-held conventional theories about dark matter, but also refuted the proposed model of Modified Newtonian Dynamics (MOND). Additionally, decades of intense effort with increasingly sensitive experiments like LZ, XENONnT, PandaX, and direct detection laboratories have not identified any dark matter particle, implying that the field of astrophysics regarding the rotation curve phenomenon, is in a state of pure chaos and ultra- confusion. Obviously, adding more exotic dark matter to all galaxies until their dynamics are suited to theoretical model is a superficial solution, because it relies on unbserved particles to create a fitting scenario rather than on a true scientific explanation based on experimental physics. More importantly, it is a well-known experimental physics fact, that the dynamic of an object is fundamentally governed by its net force rather than its energy. Energy (a scalar) describes the state of a system and its capacity to do work, force (a vector) is the agent that changes an object's velocity, direction, or shape, causing acceleration. Therefore, according to my simple mind, the flat rotation curve is a galactic- dynamic phenomenon, not a hidden cosmic-energy phenomenon, and its misunderstanding is rooted in the most basic defect in theoretical physics, namely the misunderstanding of the fundamental force in nature and its manifestations. However, the explanation of this phenomenon can be found in the intertwined fields of atomic-subatomic physics and electromagnetism. Specifically, it can be found in the dynamics of atomic and subatomic entities which are profoundly influenced by magnetic fields. In other words, this defining feature of a very fast rotating galaxies has nothing to do with the existence of a hypothetical dark matter, rather it shows the exclusively decisive role of magnetic fields in galactic kinematics, especially in case of super spiral galaxies which possess super-intense magnetic fields at their cores.

The Shape and Rotational Speed of a Galaxy are Primarily Determined by its Central Magnetic Field: The distribution of charges within physical entities to three possible types is a fundamental fact of nature and valid from the smallest physical structures to the largest ones. On the other hand, the law of conservation of charge dictates that the net charge in an isolated system remains constant, but this does not mean the net charge must always be zero. In fact, even if an object is electrically neutral, its charges and density are often distributed unequally within it, a phenomenon known as polarization. But, current astrophysical consensus is considering all galaxies to be electrically neutral, and this view is scientifically unrealistic for different reasons. First, galaxies contain vast amounts of plasma, protons, electrons, and charges are not always distributed in a way that their total sum is zero. Second, a galactic core, particularly Active Galactic Nuclei (AGN), behaves in a manner consistent with magnetohydrodynamic (MHD) principles, where rotating plasma and strong magnetic fields function as a cosmic engine, often compared to electromagnetic generators. It influences star formation, regulate galaxy evolution, and power luminous activity like quasars. More importantly, based on standard electromagnetic theory, a system driven from its center by a magnetic field—such as a homopolar motor or a similar magnetohydrodynamic setup—must exhibit a non-zero charge density or, at minimum, a non-zero electric field, meaning it cannot be truly electrically neutral in all aspects of its operation. In other words, a system that utilizes a magnetic field to create motion from a central pivot point (like a Faraday disk) relies on the separation of charges to produce an electric field, making it impossible to maintain absolute electrical neutrality in the conducting parts during operation. So, definitely, galactic net charges exist and vary significantly, while some galaxies have overall positive or negative charges, and others are electrically neutral, just like particles which are classified by their electric charge (positively charged, negatively charged, or electrically neutral). It is worth noting, that recent observations from JWST particularly from the Advanced Deep Extragalactic Survey (JADES), have shown that not all galaxies spin in the same direction, but that a significant majority — about two-thirds — appear to rotate clockwise.[78] That is a clear evidence that galaxies possess net positive or negative charge, while others are electrically neutral. The spin direction of electrically neutral galaxies is determined by their internal magnetic fields, where some of them spin clockwise, while others counter-clockwise. Therefore, a galaxy resembles an atomic-subatomic structure, and not just as a conceptual analogy, but in actual physical sense. That is to say, the primary force which rules the interactions and magnetohydrodynamics (MHD) processes of galaxies is also the electromagnetic force, exactly like in the case of subatomic particles and atoms. The central magnetic field of a galaxy is certainly playing the dominant role in determining its shape, rotational speed of its stars and in controlling the degree of its overall dynamics.

However, it is worth noticing that spiral and super spiral galaxies possess exceptionally high electromagnetic luminosity, often exceeding the brightness of traditional, giant elliptical galaxies. That in itself is a clear indication that those galaxies have net charges, because the electromagnetic luminosity of an object is directly related to its net charge, particularly in dynamical systems where charges are accelerating or orbiting. A charged particle emits electromagnetic radiation (and therefore has electromagnetic luminosity) when it accelerates, a phenomenon fundamentally linked to its charge. Furthermore, galaxies especially spiral and super spiral ones are filled with ionized gas (plasma) and magnetic fields, where charged particles, such as cosmic rays (electrons, protons), move along magnetic field lines in helical trajectories. Hence, it is not unrealistic to propose a theoretical model of kinematics and dynamics of galaxies, analogous to charged particle moving in an electromagnetic field. Definitely, if a charged particle, an ionized atom or a charged galaxy will move in a uniform magnetic field, it will follow a helical trajectory or a circular one, depending on the strength of the magnetic field. In case, the field is very strong the path will be a spiral, not a circular one, and if the field is ultra-strong it will follow super spiral path. The stronger is the field, the tighter is the spiral. A very intense magnetic field ***B*** exerts a greater force, which results in a smaller radius of curvature, causing the galaxy to spiral more tightly around its field lines, namely the magnetic force acts as a centripetal force, creating a circular or spiral path. In case of an extremely intense magnetic field the radius of the spiral (the gyroradius), would become smaller, causing the particle/galaxy to be tightly bound to the field lines. Note, that field lines are a concept tool showing the strongest regions of a magnetic or electric field through their density. Since, the magnetic force (***F = qv X B***) is always perpendicular to the velocity ***v*** of the object, the magnetic field does no work on the object. As a result, the speed (kinetic energy) of the particle/galaxy remains constant throughout its trajectory**.** So, super spiral motion is a combination of two primary motions induced by the electromagnetic field. The perpendicular component of the velocity causes the particle to spiral tightly around the magnetic field lines, and in the presence of an additional electric field, the particle experiences a drift, causing the center of its spiral to move perpendicular to both the electric and magnetic fields. The same process happens on a cosmic scale, a highly charged galaxy will move in super spiral path, primarily due to the Lorentz force, that acts perpendicularly to both the galaxy's velocity and its magnetic field lines, which are ordered and aligned along the spiral arms (magnetic fields are forming helical structures that wrap tightly around the spiral arms). Thus, one can understand why the rotation curves are more pronounced, in super twisted galaxies (super spirals) compared to normal spiral galaxies like the Milky Way. Also, in case of ultra-strong fields, the galaxy will accelerate to super speeds, leading to the production of high amounts of synchroton radiation, and that is the real reason why super spiral galaxies produce a significant excess of synchrotron radiation. **Obviously, with the consideration of magnetic rotation of galaxies, one does not need to invoke dark matter to explain rotation curves.**

Conclusion

All types of cosmic explosions, including stellar flares, are ruled by electromagnetic interactions, where the external magnetic fields play the major role. Stellar flares are the most minor, frequent, and weakest type of explosion (minor explosions) or transient phenomenon on a star's surface compared to more dramatic events like novae, supernovae, or rapid catastrophic disruption. While stellar flares are energetic–often releasing energy up to 10^{32} ergs for a solar flare and much more in super flares on other stars – they do not destroy the star itself.

However, as the rate and intensity of electromagnetic radiation that the star receives increase, the explosion becomes more dramatic. In some cases, only the outer layers of the star are ejected and a long time is needed before total destruction occurs; in other cases, the ejection of the outer layers would be followed within a short period of time with the explosion of the core. The other extreme case is the rapid, catastrophic disruption of a star, which is not triggered by the sudden loss of energy required to counteract gravity, but rather by exposure to ultra-intense, external electromagnetic radiation.

On the other hand, the super-intense magnetic fields at the centers of galaxies are the determining factors in their shapes and rotational dynamics. Those regions possess extremely intense magnetic fields, identical to the intensity of magnetic fields at the centers of mass of subatomic particles, such as the proton and electron. Also, the birth of stars is ruled by electromagnetic processes, particularly in high-density environments like the centers of galaxies, where magnetic fields play a critical role in controlling the collapse of cosmic material, and regulating star formation rates. Recent observations of merging galaxies, such as Arp 220, show that magnetic fields are significantly more powerful than previously thought, holding star-forming material together and preventing it from dispersing due to intense heat, acting like a pressure cooker.

Furthermore, and most importantly, the true nuclear fusion reaction that occurs in the sun is a condensed matter nuclear fusion process, driven by electromagnetic interactions and powered by galactic magnetic fields that carry high-energy charged particles (cosmic rays). This external flow is not chaotic, but is modulated, transported, and regulated by the Sun's complex magnetic fields, specifically by the Heliospheric Current Sheet (HCS) and the Solar Polar Fields (SPF). Basically, the sun is not a self-sufficient, self-sustaining nuclear reactor, but a condensed matter entity with a real surface and powered by Galactic Cosmic Rays. There is a very long list of observational evidence that makes a convincing case for the condensed matter nature of the sun. In fact, the existence of sunspots is in itself sufficient evidence refuting the claim of an optical illusion surface. That is because sunspots cannot be formed without surface tension, and surface tension is exclusively a property of liquid surfaces - and some solid interfaces - resulting from cohesive forces between molecules. In other words, molecules inside a liquid are pulled equally in all directions, but surface molecules are only pulled inward. This creates an inward, cohesive force that minimizes surface area, often forming spherical shapes, while plasma, an ionized gas, lacks these cohesive intermolecular bonds and does not exhibit surface tension. It consists of free electrons and ions, not cohesive molecules that can form a stable, skin-like surface.

Note that even if the temperature in the center of the Sun is one hundred times higher than the estimated current value, it would still be impossible to obtain a self-sustained thermonuclear reaction (ignition). The reason has to do with the fact that the intensity of the magnetic field inside a proton (its internal magnetic field strength) is colossal, which is a direct consequence of its extremely high density and rapid spin. Namely, while the magnetic moment of the proton is relatively small compared to that of an electron, the extremely tiny volume of the proton means its internal magnetic field strength is immense. Theoretical calculations and measurements indicate that the magnetic field within the center of mass of a proton is exceptionally strong, estimated to be on the order of 5.09×10^{31} Tesla. That is far stronger than the magnetic field on the surfaces of magnetars which is around 10^{11} to 10^{13} Tesla. The colossal strength of the magnetic field within the center of mass of the proton means that at very short distances, the repulsive force becomes infinitely large, and the process of thermonuclear reaction is impossible. In other words, the potential barrier can never be penetrated, but it can be overcome when its height is substantially reduced. Note that as the potential barrier becomes thinner, its height is also reduced enormously.

It seems to us that the only way to convince the scientific community is to provide a practical model of how fusion reactions occur in the sun. This revolutionary model can be provided only through agreement, not by publishing it in a journal or making it public.

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