EINSTEIN'S KEY TO HUBBLE REDSHIFT

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Abstract. In 1907 Einstein discovered the key to understanding accelerating Hubble redshifts. By assuming that acceleration and gravity are equivalent ("The Happiest Thought of my Life"), he proved that Maxwell's equations are the same in every accelerated reference frame but that vacuum permittivity depends on the acceleration. Vacuum permittivity is the scalar in Maxwell's equations that determines the speed of light and the strength of electrical fields. Maxwell's equations are valid in every coordinate system in general relativity. Vacuum permittivity depends on the spacetime curvature. For Friedmann spacetime, vacuum permittivity is proportional to the radius of the universe. When the radius changes, changing electrical fields in atoms change the wavelengths of emitted photons by about twice as much as photon wavelengths change. This is the key Einstein left us: The evolution of both photons and atoms must be used together to understand Hubble redshift. When this is done, the physics of Maxwell, Einstein, Bohr, and Friedmann fits modern Hubble redshift observations beautifully.

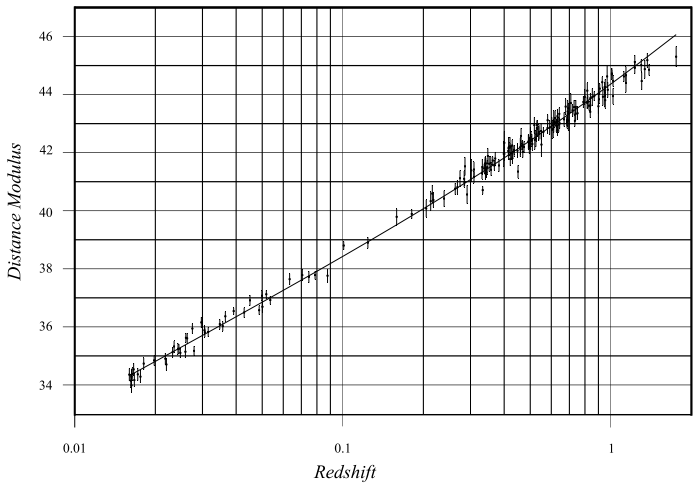
In 1907 Einstein [1] [2, p 252] summarized the status of special relativity and its implications in the two years since its publication[1]. At the end of his survey he concluded with a speculative section on "The Principle of Relativity and Gravitation." He considered an uniformly accelerated coordinate system and assumed that locally it is equivalent to a gravitational field. Einstein concluded that Maxwell's equations in the accelerated coordinate system (and hence in a gravitational field) are exactly the same as they are in the inertial coordinate systems of special relativity, except that "The principle of the constancy of the velocity of light does not hold ... the velocity of light in the gravitational field is a function of place ..." [4] [5, p 385]

In Maxwell's equations, vacuum permittivity is the scalar that determines the speed of light and the strength of electrical fields. Einstein's discovery means that both the wavelengths of photons and the wavelengths of photons emitted by atoms change with gravity in special relativity and with spacetime curvature in general relativity.

In the Friedmann universe, vacuum permittivity is directly proportional to the Friedmann radius [6] and is therefore a function of time. As the size of the universe evolves, the changing strength of the electrical forces between charges changes atomic energy levels, shifting the wavelengths of emitted light. The shift in photon emissions due to the evolution of electrical attraction in atoms is about twice as large as the evolutionary shift in photon wavelength. Taken together the evolution of atoms and photons reverses the current interpretation of Hubble redshift to imply that the Friedmann universe is closed and is now accelerating in collapse.

[1] Abraham Pais [3, p 177] wrote a superb chapter about this paper, "The Happiest Thought of my Life".

Since atoms as well as photons change in time, it is necessary to rederive the connection between measured Hubble redshifts, the Hubble constant H_o, and the deceleration parameter q_o. When this is done, modern accelerating supernovae redshifts are beautifully fit by varying just the two parameters that characterize the Friedmann solution. This is a typical fit to modern data [7]. Note that H_o is negative during collapse and that q_o is essentially $\frac{1}{2}$ which implies that the universe is very nearly flat.



Supernovae redshift data from Davis et al. [8] Solid line fit using the Friedman solution with the parameters $H_o = -66.5\,km\,s^{-1}Mpc^{-1}$ and $q_o = \frac{1}{2} + (0.001)$.

Thank you Albert Einstein!

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