Hubble and Humason measured redshift

Introduction and relevance

The trouble with the Hubble law is that it is based on the *assumption* that *low* speed is the *only* cause of redshift of galaxies. You then get: z = v / c (low speed Doppler) and z = H.D / c resulting in v = H.D, the Hubble law, in which "z" is the redshift, "v" is the galaxy speed, "c" is the speed of light, "H" is the Hubble constant, and "D" is the distance to this galaxy. The assumption of Hubble and Humason in 1931 of the Doppler Effect (and thus galaxy speed) being the *only* cause of redshift should be reexamined. In 1931, they measured redshifts of up to 0.063, while we measure nowadays redshifts of galaxies with the Hubble Space Telescope of up to 11.1!

Observations of high redshifts "z" force us to formulate an *advanced* Hubble law. The advanced Hubble law combines low speed and distance into one formula explaining observed fast star formation, explaining local (peculiar) speed, and extending the cosmic inflation epoch to the entire cosmic past. It allows us to separate local speed effects from distance effects. It also allows us to establish the Hubble constant more accurately, resulting in a new model of the universe conserving energy as Noether and Einstein would have appreciated.

What is redshift?

Redshift is the change in the spectrum of light between the source and the observer expressed as a number "z". Redshift zero means that you receive the same spectrum. A redshift "z" of 0.5 means that blue light (wavelength 460) at the source is received as red light (wavelength 690), hence the name redshift. A redshift of 0.5 means receiving a wavelength that is z + 1 times larger (1.5 x 460 = 690) than transmitted.

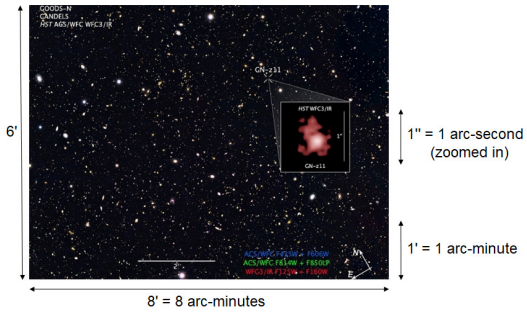

Figure 1: Redshift of galaxy GN-z11

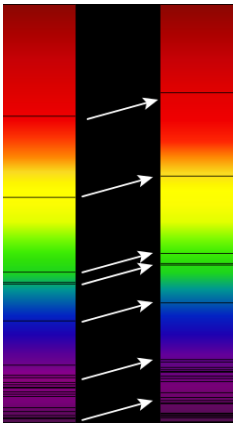

Figure 2: Absorption lines shifted

In figure 1 you see the picture of the Hubble Space Telescope of galaxy GN-z11 with an infrared camera. The spectrum of light of all those stars in this galaxy as you would observe close by, is very similar to sunlight. Yet, on earth we can only see this same white light with

infrared cameras. The wavelengths transmitted at GN-z11 are received on earth as twelve times (z + 1) larger. The spectrum of starlight has many black lines in it, the so-called absorption lines, see figure 2. These absorption lines are caused by the outer layers of stars containing hydrogen and helium (and other atoms) absorbing photons of light at specific wavelengths. These absorption lines shift along the spectrum of the sun. That's why we can measure redshift so easy, we just have to shift the received absorption lines until these match up with sunlight! For example, even though GN-z11 is extremely far away from us (billions of light-years), we know that its redshift is 11.1 with an error of just 0.1!

Redshift caused by receding speed (Doppler)

Christian Doppler discovered the Doppler Effect of sound. A train coming towards you has a higher sound, while a train receding from you has a lower sound (a longer wavelength). This also applies to light, receding galaxies are redshifted (GNC 3109: z = 0.001), while galaxies nearing us are blueshifted (like Andromeda). Blueshift is negative redshift. For example, Andromeda has a redshift z = –0.001. A Doppler based formula for redshift by receding galaxies is simple: z = v / c, in which "v" is the receding speed and "c" is the speed of light.

Many astronomers (including Edwin Hubble) think/thought that speed is the *only* cause of redshift of stars and galaxies, that's why you see redshift very often expressed in terms of speed. To stay scientific, you have to express redshift as a number, that's what is measured. S*peed as only cause for redshift is an assumption*. Both Albert Einstein and Alan Guth cum sui would *contradict this assumption*! How did it get to this? Let's have a look into the original document of Hubble and Humason in 1931.

Hubble and Humason

Edwin Hubble and Milton Humason wrote in their document "THE VELOCITY-DISTANCE RELATION AMONG EXTRA-GALACTIC NEBULAE" (1931) page 73: "The quantities actually observed in the present investigation are red-shifts and apparent magnitudes. The relation between them is so definite and significant that it may be emphasized before interpreting the magnitudes in terms of distance. The fact that the red-shifts are expressed on a scale of velocities is incidental; for the present purpose they might as well be expressed as $d\lambda/\lambda$"[1], see footnote.

Redshift "z" is measured as the change in wavelength "$d\lambda$" divided by the wavelength "λ". On page 76 of that same document you will find the Hubble law: $v_{exp} = 558 \times D$, in which "v_{exp}" would be the universal expansion speed in [km/s], "D" is the distance to the galaxy in [Mpc] and is "558" what is now called the "Hubble constant" symbolized by "H" in [km/s/Mpc]. The Hubble law is described as $v_{exp} = H.D$. The Hubble constant "H" has gone down considerably since then, the current value used by many cosmologists is 67.8 [km/s/Mpc].

For example galaxy GNC 3109, the farthest galaxy in our local group of galaxies at a distance "D" of 1.33 Mpc, would have a universal expansion speed "v_{exp}" of 67.8 x 1.33 = 90 [km/s]. When you look at the specified redshift "z", you see sometimes a dimensionless 0.001 345 and sometimes a speed of 403 [km/s]. The conclusion of many cosmologists is that GNC

[1] Hubble E. Humason M. "THE VELOCITY-DISTANCE RELATION AMONG EXTRA-GALACTIC NEBULAE" 1931 p. 73

3109 is speeding away from us at 403 [km/s], of which 90 [km/s] would be the expansion speed "v_{exp}" and 313 [km/s] would be the local speed "v_0". The local receding speed "v_0" creates an additional redshift caused by the Doppler Effect of v_0 / c, in which "c" is the speed of light.

However, Hubble and Humason *did not measure any galaxy speed at all*! How did the Hubble law then conclude the expansion speed "v_{exp}"? The only thing they measured was the redshift "z", while the distances were estimated by other methods (Cepheids and observed apparent magnitudes). The relation they found was a relation between *redshift* and distances, *not of velocities* and distances. This relationship was $z \approx H.D / c$, in which "z" is the dimensionless redshift and "c" is the speed of light. Loop-Doctor therefore objects, with hindsight, to the title of the document, the title should have been: THE *REDSHIFT*-DISTANCE RELATION AMONG EXTRA-GALACTIC NEBULAE", that would have been good science!

The reason Hubble and Humason got to the Hubble law is based on the *assumption* that speed is the *only* cause of redshift. If speed would be the only cause of redshift, then the (relativistic) Doppler Effect applies. The redshift "z" would then be total speed "v" ($v = v_{exp} + v_0$) divided by the speed of light ($z = v / c$). Combining that with the redshift distance relation Hubble and Humason found, would get you to the Hubble law: $v_{exp} = H.D$. However, where is the proof?

The trouble with Hubble

Let us take the far galaxy GN-z11, discovered by Leiden University as example. Let us *assume* that this galaxy has no local speed "v_0", we can then further reduce the Hubble law to:

$z = H.D / c = v_{exp} / c$ [ ] redshift of far galaxies according to the Hubble law (1)

Leiden University has measured a redshift of 11.1 with an error of 0.1, which is about eleven hence the name "GN-z11"; we will use the value 11 for simplicity. We can now compute the distance "D" based on formula (1), this amounts to 11c / H. However, we can only see as far as c / H, the so-called Hubble length, GN-z11 would be eleven times farther than we can see! This is the "horizon problem" of the Hubble law, you cannot see farther than the Hubble length. We can also compute the expansion speed "v_{exp}" using formula (1), which then comes to eleven times the speed of light! Einstein would grumble.

Many astronomers would argue that the *relativistic* Doppler Effect applies here. In that case the speed of GN-z11 and thus the expansion speed would come to about 92% of the speed of light and the distance to 92% of the Hubble length.

However, we then get into the most serious problem of the assumption that speed is the only cause of redshift. The acceleration of the expansion is a logical consequence of the Hubble law since acceleration "a" is the differential of speed "v" over time. We thus get $a_{exp} = H^2.D$. The acceleration of the universe gets larger the larger the distance "D" gets! Acceleration takes up energy, where does that energy come from? To stick with the Hubble law as it is, requires not just "dark energy", but *ever increasing* "dark energy" because of the accelerated expansion. Would the end be a universe with "dark energy" only? And where is the particle of "dark energy" in the standard model?

Hubble and Humason measured redshift

Let us look again at the original document on page 73 stating: "The fact that the red-shifts are expressed on a scale of velocities is **incidental**". The Hubble law is based on the incidental *assumption* of two people only, not on real physics: not by *expansion speed* measurements. So far, Loop-Doctor supports only their scientific finding: the relation between *distance* and redshift is overwhelmingly clear. That relation is $z = H.D / c$ for low redshifted galaxies as measured by Hubble and Humason in 1931 ($z < 0.063$).

Redshift caused by gravitation

Einstein showed us in 1915: Gravitation causes redshift too. Light from a source close to a black hole is redshifted. Redshift caused by gravitation lies in the range from zero to about a half ($0 < z < 0.53$), although most visible stars have a very low redshift caused by gravitation. Albert Einstein provided us with the formula for gravitational redshift, but that is not relevant for the redshift of whole galaxies as a collection of the light of billions of stars. This is not a bad assumption. A galaxy exists out of many stars similar to our own star, the sun. The redshift of the sun as measured on earth is only 0.000 002 122. So the two main causes of redshift of whole galaxies are speed (Doppler) and cosmic inflation (Guth).

Redshift caused by cosmic inflation (Guth)

Cosmologists long wandered how it is possible that the universe developed so fast long ago. Without a fast development of the universe long ago, many observations cannot be explained. That's how we know that somewhere in the cosmic past the time must have gone way faster than the time is proceeding now. So cosmologists like Alan Guth, Andrei Linde, and Alexei Starobinsky talk about the "inflation epoch". Cosmic inflation is defined as how much faster physics proceeds relative to our current progress of physics. However, how much faster and how long it lasted is not yet established by scientists. Let's look at observations.

NASA/ ESA observations

NASA/ESA published in: "Hubble finds hundreds of young galaxies in the early Universe" about fast star formation in baby galaxies at a redshift around nine:

"The findings also show that these dwarf galaxies were producing stars at a furious rate, about ten times faster than is happening now in nearby galaxies".

This is incidental observational proof of cosmic inflation of galaxies of redshift plus one. The Doppler Effect of receding galaxies *would mean the opposite*, star formation would be observed to proceed ten times slower! The conclusion must be: *Speed cannot be the main cause of the redshift for these baby galaxies*! This is where "Quantum Relativity" comes in, a new theory of four academic engineers from the Netherlands, calling themselves the "Loop-Doctors" or simply "Loop-Doctor".

Alternative cause of the distance term H.D / c

Loop-Doctor provides you with an alternative cause for the distance term: cosmic inflation. Cosmic inflation is the ratio of the cosmic clock relative to our current clocks. A cosmic inflation of 1 means a clock that ticks equally fast as ours. A cosmic clock with cosmic inflation of 10, means that this clock ticks ten times faster than our clocks on earth. Since the

clock is our measurement of time, that means that the laws of physics also proceeded ten times as fast as we measure on our clocks. For example, in the "inflation era" physics proceeded about 10^{50} times faster than today. The formula is simple, cosmic inflation equals z + 1. This means that the larger the distance "D", the higher the redshift "z" and the faster physics proceed. It also means that cosmic inflation is not limited to the inflation epoch, but is a property of the whole cosmic past! Over distance, this works out as:

$z = H.D / (c - H.D)$ [ ] redshift caused by cosmic inflation over distance (2)

For small distances (c >> H.D), this means: $z \approx H.D / c$, exactly the relation Hubble and Humason discovered in 1931! We can now present you with the "advanced Hubble law", which includes the effect of local (peculiar) speed "v" and distance "D" caused by cosmic inflation:

$z = v / c + H.D / (c - H.D)$ [ ] *advanced* Hubble law (3)

The second term is exactly what Hubble and Humason concluded before they assumed speed to be the only cause of redshift. This second term is the cosmic inflation term. *In other words, Hubble and Humason were (unwittingly), the first to discover the effect of cosmic inflation*, see figure 3:

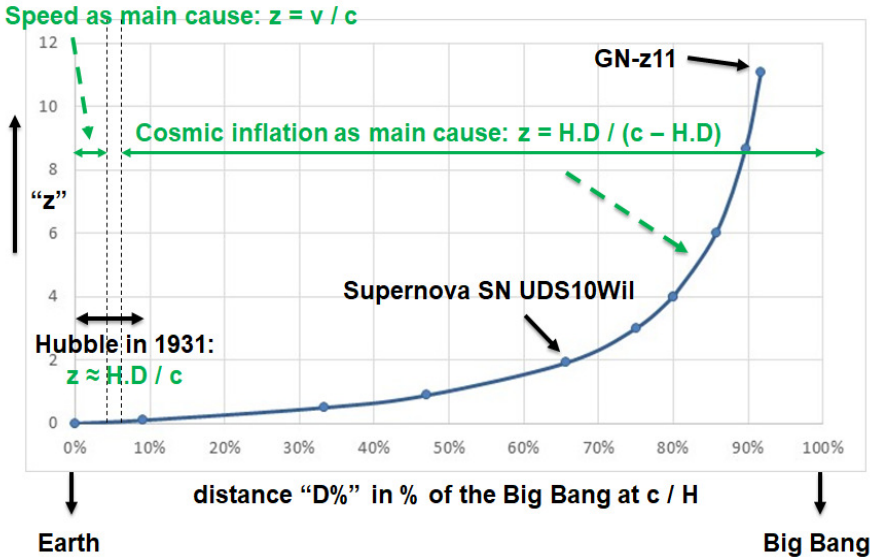

Figure 3: Redshift "z" as caused by local speed "v" and distance "D"

The advanced Hubble law explains all galaxy redshifts as a *combination of local speed and cosmic inflation*.

Hubble and Humason measured redshift

Highly redshifted galaxies

For example, GN-z11 is at a distance of 4,060 [Mpc] or 13.2 billion light-years away from us, assuming no local speed and a Hubble constant of 67.8. Observed physics proceed 12 times faster at GN-z11. If you would apply relativistic Doppler to GN-z11 assuming high speed would be the cause of redshift, everything would proceed 12 times *slower* than on nearby galaxies. Initial estimates of star formation amount to 20 times faster for GN-z11, making cosmic inflation a more likely candidate for the cause of redshift than speed! So, what do we conclude from the redshift GN-z11? The major cause of redshift is likely to be the cosmic inflation term.

However, astronomers in Leiden have estimated star formation to go even faster than 12 times (based on z + 1) namely, 20 times faster. What could explain that difference? Local speed? No, real speed measurements of galaxies in our local group do not exceed 600 [km/s]. Other causes could be at work, like a higher abundance of hydrogen, or a much higher Hubble constant, or a combination of these factors; we simply don't know yet. In figure 3 you see the graphics of the advanced Hubble law: if measurable, z would increase to infinite at the Big Bang, which is a only a horizon.

Consequences of the advanced Hubble law

The advanced Hubble law combines speed and cosmic inflation into one formula confirmed by NASA/ESA observations of fast star formation, galaxy speed within our local group, and the cosmic inflation epoch. This formula confirms Hubble and Humason's original data too. It separates local speed effects from distance effects. It explains the redshift of newly-found highly-redshifted galaxies, and also allows us to establish the Hubble constant more accurately.

In practical terms, it means that Andromeda nears the Milky Way even faster than currently estimated. The most surprising consequence is the new model of the universe, a model in which the universe conserves its energy, while there is no need for "dark energy" and little or no need for "dark matter" (see other articles).

More information?

Our books and articles, see www.loop-doctor.nl describe the history of the solutions and the repair for Noether's theorems[2] in full detail. We hope you get as many "aha" experiences as we did,

Rob Roodenburg (MSc. author),
Frans de Winter (MSc. coauthor),
Oscar van Duijn (MSc. coauthor),
Maarten Palthe (MSc. editor).

Schiedam, November 2019

[2] Noether E. "Invariant variation problems" translated by Tavel M. TTSP 1971 p. 186-207