CORRESPONDENCE

To the Editors of 'The Observatory'

Which Law is Hubble's Law?

In her reply to Nussbaumer & Bieri[1], Trimble[2] writes of "the linear velocity–distance (or redshift-magnitude) relationship that we now call Hubble's Law" and of "the redshift-magnitude, velocity–distance, *etc.*, relationships". Perhaps some of the debate over whom the Law should be named after is due to the fact that different people use the term 'Hubble's Law' to mean different things. Harrison[3] discusses the distinction between what he calls the redshift–distance and velocity–distance laws. The former is what Hubble[4] discovered (with, of course, input from others), but the title of his paper mentions "a relation between distance and radial velocity", using apparent magnitude as a proxy for distance and redshift as a proxy for velocity.

As Harrison points out[3], the linear velocity–distance relation is theoretical, involves unobservable quantities and, in a universe described by the Robertson–Walker metric[5,6,7], is exact: it is the only velocity–distance relation possible in a universe which is homogeneous and isotropic at all times. By contrast, the redshift–magnitude relation is observational, involves quantities which can be 'directly' observed, and is approximate both observationally (because of contamination of the cosmological redshifts by redshifts due to peculiar velocities and because of scatter in the absolute magnitudes) and theoretically (since, in general, it holds only in the limit of zero redshift when computed based on the assumption of a Friedmann–Lemaître cosmological model).

The constant of proportionality is, in both cases, the Hubble constant. While Hubble's interpretation of apparent magnitude as distance and of redshift as velocity are both valid only in the limit of zero redshift (at least if the velocity is interpreted as the temporal derivative of the distance), one can nevertheless use this to measure the (same) constant of proportionality for the theoretical velocity–distance relation, which is valid at all velocities and at all distances. As emphasised[3] by Harrison, it is at best confusing to even think about the Doppler effect in this context (though many do so), but Bunn & Hogg demonstrate[8] that this is possible after all if one uses the appropriate definitions of velocity and distance, though I hasten to point out that the velocity involved is one which, as far as I know, has no other use in cosmology.

Ironically, Hubble himself, while never as keen on theoretical interpretation as on the observations themselves, probably doubted that the expansion was real[9].

Yours faithfully,
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