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CORRESPONDENCE

To the Editors of 'The Observatory'

Exquisite Precision

In a recent book review[1], in reference to one of the échelle spectrographs with a precision of 10 cm s^{-1} on the ESO *Very Large Telescope*, Tatum wondered "... whether astronomers can really make use of such exquisite precision". There are at least two fields of study where the answer is 'yes'. One involves the detection of exoplanets *via* the changing radial velocity of a parent star. The change in the radial velocity of the Sun due to the Earth is about 10 cm s^{-1}. Thus, even higher resolution would be needed in order to detect less massive and/or more distant planets around Sun-like stars, and even more if the system is not seen edge-on. The same goes for a more massive star, and moreover in such a case a planet in the habitable zone would be further away as well, reducing the change in radial velocity even more.

The other, at the other end of the astronomical scale, is cosmology. The cosmological redshift z is given by $R_0/R - 1$, where R_0 is the scale factor now and R the scale factor at the time of emission. One usually assumes that R_0 is constant, since time-scales directly familiar to humans are orders of magnitude shorter than the light-travel time from an object with a significant cosmological redshift. Looking at the back of an envelope, the age of the Universe of about 10^{10} years means that one might expect z to change by about 10^{-10} in a year. The speed of light is about 3×10^{10} cm s^{-1}, thus such a spectrograph could detect the change in cosmological redshift within a few years. The details depend on the cosmological model, and one can determine the cosmological model by measuring this so-called redshift drift as a function of redshift, which is particularly interesting since there is no possibility of confusion due to evolutionary effects.

The above discussion assumes two (or more) measurements at different times, each of which would correspond to a different time of emission. However, in a gravitational-lens system in which one sees more than one image of the same object, in general the light-travel time will be different. For a galaxy lens, that is on the order of months while for a cluster of galaxies the time delay could be a thousand years or so. In such a case, one could measure the redshift drift in a single night by taking spectra of each image. In the case of a cluster lens, due to the much longer time delay, the redshift drift could be greater than that which could be measured by observing the same single-image object over the lifetime of an astronomer. If the cosmological parameters are well known, one could effectively measure the time delay *via* measuring the difference in redshift between two images of the same object, which could constrain the mass distribution of the gravitational lens.

The idea of redshift drift is older than I am[2]*, but has received more attention recently due to the possibility of actually measuring it; there is an ESO Key Programme for the task[3]. More details, especially for redshift drift in the context of strong gravitational lensing, can be found in my latest paper in *MNRAS*[4].

Yours faithfully,
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* Sandage was both pessimistic about improvements in spectroscopy and optimistic about the future of humanity: "[A] precision redshift catalogue must be stored away for the order of 10^7 years ..." and "... data for extragalactic astronomy must be collected from ancient literature."