Spectral variations on a universal theme

Every now and then scientists reexamine those normally unquestioned assumptions that allow them to get on with their business. Now, physicists and astronomers are questioning one such assumption relating to the physical origin of what they call the "redshift" of starlight and suggesting that amendments may be necessary. Compared with a stationary source of light, wavelengths emitted from a receding source are lengthened, or redshifted. Finding this property in spectra of celestial sources led to the discovery more than 50 years ago that the universe is expanding.

Redshift is widely thought to result predominantly from the recessional movement of celestial bodies, that is, from Doppler shift. Astronomers call this cosmological redshift. But there has always been a minority of scientists who have argued that Doppler effects may not be the entire story behind the measured redshifts. Any amendments to redshift theory would change how cosmologists view the universe, particularly how they measure its size.

Emil Wolf, a physicist at the University of Rochester (N.Y.), is one of the newer members of that minority, which includes Halton Arp, now at the Mt. Wilson Observatory in Pasadena, Calif. Since the 1970s, Arp has been presenting controversial evidence in which several celestial bodies, each with different redshifts, appear to be clustered in space. He argues that such evidence suggests there is more to redshift than the Doppler effect.

"Preliminary calculations," Wolf told SCIENCE NEWS, "seem to support a theory I am developing that there is a noncosmological redshift," i.e., non-Doppler redshift.

Physicists have generally assumed that once light leaves its source, its spectrum does not change. However, Wolf suggests that spectra from "unconventional light sources . . . and stellar objects of an unfamiliar kind" may vary or "evolve" during the journey across the great intergalactic distances. That the spectra of light emitted by common sources like lightbulbs and flames are invariant on propagation, Wolf comments, "is undoubtedly largely responsible for the commonly held, but nevertheless incorrect, belief that spectral invariance is a general property of light."

In an article in the March 31 PHYSICAL REVIEW LETTERS, Wolf sketched out the mathematical foundation of his theory, which allows for sources that emit noninvariant spectra. Since the article appeared, Wolf has added some flesh to the sketch. He told SCIENCE NEWS he is submitting a follow-up article this week to NATURE. In it, he says, he explains how part of the measured redshift values of objects like quasars and so-called superluminary sources might be accounted for by an optical measure, called the "degree of coherence." This measure characterizes the way in which the fluctuations of light emitted from the individual atoms that make up a source of light correlate with each other.

"The essential point is that the coherence properties of a source are . . . put into the light right at the beginning when it is starting from the millions of elementary sources," Wolf explains. As the emitted light travels through space, the spectrum evolves, adding a non-Doppler component to the redshift detected on earth. The changes that occur in the spectrum are "sort of coded into the light due to correlations in the source."

According to Wolf, two of his colleagues at the University of Rochester are using special lenses to obtain experimental results that actually show noninvariant spectra. Laboratory demonstrations of such spectral noninvariance strengthen Wolf's suspicion that there may be similarly behaving sources in space.

In addition, astronomers are offering observational evidence that might strengthen Wolf's theory. In the Oct. 15 ASTROPHYSICAL JOURNAL, Arp and Jack Sulentic, astronomer at the University of Alabama at Tuscaloosa, will present evidence of galaxy pairs in which each member has a different redshift. Arp presented some of this evidence to a skeptical but interested audience at the International Astronomical Union's recent conference in Beijing, China.

According to standard theory, objects that are the same distance from the earth should show the same redshift. Thus, the researchers argue, the galaxy pairs constitute evidence of some non-Doppler source of redshift.

If these observations do ultimately stand up to scientific scrutiny and if Wolf is correct in his claim that a component of redshift is due to optical coherence properties, our picture of the universe will have to be touched up.

For instance, Wolf says, astronomers would have to reinterpret the large redshifts of quasars by subtracting a non-Doppler component. Thus, estimates of the size of the observable universe would shrink considerably — perhaps, says Wolf, by a factor of 100 or more.

Many astronomers remain dubious. The anomalies upon which Arp, Sulentic and now Wolf rely can be explained as optical illusions, they say, without any talk of noncosmological redshift. Wolf, however, is confident that theoretical and experimental evidence soon to be presented will bring the skeptics around his way. — *I. Amato*

Bird's-eye view of early primate scene

Scientists have confidently projected an estimate of what the climate was like around 30 million years ago at the site of the earliest known human and ape ancestors, thanks to a small collection of bird fossils from the same deposit. The analysis of the 25- to 30-million-year-old birds in the Sept. 12 SCIENCE indicates that they inhabited a tropical swampland bordered by rain forests and patches of grassland.

A 1982 study of sediments, plant fossils and primate skeletons from the Egyptian site, known as Fayum, suggested that 30-million-year-old precursors of modern humans and apes spent most of their time in the trees of dense forests with heavy seasonal rainfall. This scenario contrasted with a British scientist's controversial assertion in 1980 that Fayum primates were ground dwellers in a semiarid, treeless scrubland.

The former description is the one that flies when bird fossils are taken into account, say Storrs L. Olson of the Smithsonian Institution in Washington, D.C., and D. Tab Rasmussen of Duke University in Durham, N.C. Unlike Fayum mammal fossils, which belong to largely extinct species, most of the 30 bird specimens from the site are clearly related to living families of birds, and several may be closely related to living species, Olson and Rasmussen find. Fossils with modern counterparts include those of jacanas, shoebilled storks, herons, cranes, cormorants, ospreys, eagles and other birds that rely on areas of open water. Their habitats today overlap only in Uganda north and west of Lake Victoria, say the researchers, where the climate is tropical, with stable rainfall throughout the year. The area is bordered by forests, open woodlands and grasslands.

"This evidence fits hand-in-glove with other evidence from Fayum that it was once made up of forests and floodbasins," says paleoanthropologist Elwyn L. Simons of Duke University, who participated in the 1982 report on the site's ancient climate. There is not enough evidence, he adds, to say for certain whether rainfall came in monsoon-like bursts or was spread throughout the year. "Modern Uganda probably isn't exactly like ancient Fayum," notes Simons.

Nevertheless, bird fossils are an underestimated resource for investigators of early human and ape environments, says Olson. For the period from around 40 million years ago to 20 million years ago, he contends, bird specimens with modern counterparts are better reflections of the climate and habitat than the more abundant remains of now-extinct mammals. — *B. Bower*