Expanding a theory for shifting starlight

If Oscar Peterson were running alongside a speeding Ella Fitzgerald as she belted out an A, he would hear an A. But if the pianist took a breather while singing Ella raced on, the Doppler effect would make the note sound lower to him.

For close to a century, scientists have known that the wavelengths of light from a rapidly receding source in outer space also get Doppler-shifted to lower frequencies and so appear redder than they would if their source remained stationary. Moreover, researchers have assumed that this so-called redshift can result only from Doppler motion or from a gravity-based mechanism also uncovered early this century.

Not so, contends physicist Emil Wolf of the University of Rochester (N.Y.). In 1986, he published a theoretical sketch of a third mechanism that could account for part of the redshift of light from exotic cosmic objects such as quasars. Several researchers have since reported laboratory confirmations of the process, which some of them refer to as the "Wolf shift" (SN: 9/13/86, p.166; 7/11/87, p.22).

Now Wolf reports an important extension of his theory, suggesting the process could account for arbitrarily large shifts toward either the red or blue end of the electromagnetic spectrum.

In its earlier form, the theory proposed a mechanism that could produce small redshifts in the spectra of light emitted from certain exotic sources. Wolf suggested at the time that the shifting mechanism could emerge physically from partially synchronized, or coherent, fluctuations in the wavelengths of light emitted from the countless individual atomic and molecular "microlamps" that make up such a source. As these emissions travel through space, their original spectrum would appear to shift in the same way as Doppler-shifted light.

Though its astronomical consequences remain unknown, the theory could change estimates of the size of the universe and help explain some anomalous astronomical observations, Wolf says. However, astronomers have not rushed to adopt it. No known light source has components that display the required correlated fluctuations, Wolf notes. He also blames the theory's unorthodoxy and its arcane mathematical formulation for its limited consideration by astronomers.

In the updated theory, described in the Nov. 13 PHYSICAL REVIEW LETTERS, Wolf outlines a more general – and perhaps physically more plausible – mechanism that could imitate Doppler shifts of any magnitude. Instead of requiring the microlamps in the source to fluctuate in some correlated fashion, he now proposes that a complex "scattering medium," such as the electrically charged and frenetic atmosphere thought to surround quasars, might serve as an unusual lens that restructures incoming light to have redshifting or blueshifting correlations upon leaving the medium. "A scattering medium of the right type between the source and an observer should produce these effects," Wolf told SCIENCE NEWS.

Wolf concedes that astronomers have never reported such a scattering medium and notes that he used simplifying assumptions in both the original and updated theories. Nonetheless, the expansion of the theory strengthens the case for a third physical mechanism underlying spectral shifts even in light from stationary sources. University of Rochester astronomer Malcolm P. Savedoff says the soundness of Wolf's theory demands that scientists take it seriously. In a paper submitted to ASTROPHYSICAL JOURNAL, Savedoff, Wolf and graduate student Daniel F.V. James have mathematically modeled scattering media that are consistent with typical models of the environment near quasars. – *I. Amato*

Genetic testing possible before conception

It wasn't so long ago that a woman had to wait until her child was born before she knew whether it suffered from some genetic defect. Amniocentesis and, more recently, chorionic villus sampling have changed that, making genetic testing possible after only eight weeks of gestation. And newer techniques suggest that artificially inseminated embryos only a few hours old – as small as the eight-cell stage – may reveal their genetic abnormalities in the petri dish before being transferred to a mother's womb, allowing her to decide whether or not to proceed with the implantation (SN: 3/4/89, p.132).

Research now suggests that genetic testing may soon become feasible even in unfertilized eggs – clearly before conception. While such tests cannot evaluate the father's genetic contributions, they could prove valuable for women at high risk of giving birth to a child with a severe genetic defect.

So far, Yury Verlinsky and his colleagues at the Illinois Masonic Medical Center in Chicago have performed the sensitive analytic technique on eight eggs from one mother known to harbor a defective gene. Of the five eggs successfully tested, two came up negative for the defective gene and were implanted in her womb following *in vitro* fertilization. Although the woman did not become pregnant, the researchers say the testing technique worked well and appears not to have been a factor in the unsuccessful implantation. *In vitro* fertilization attempts typically have high failure rates.

To perform their analysis, the researchers take advantage of a natural quirk of egg production. While most human cells contain 46 chromosomes (23 from each parent), egg and sperm cells contain only half that number. During the specialized cell division that leads to the creation of egg cells, the leftover complement of 23 chromosomes gets packaged into a smaller cell called a polar body, which remains attached to the egg but eventually wastes away. In a woman who has inherited a normal gene from one parent and a defective version of the same gene from the other parent, the question of which gene her child will inherit boils down to one random event: Will the good gene end up in the mother's egg cell, or in that egg cell's polar body?

Direct tests on the egg would destroy that cell. So, after retrieving several eggs from the woman's ovary, Verlinsky and his co-workers carefully removed each egg's polar body and performed sensitive genetic tests on these. When the polar body harbored the normal gene, they knew the egg contained the abnormal one. When the polar body contained the abnormal gene, the researchers fertilized the corresponding egg with the husband's sperm and implanted the young embryo in the woman's uterus.

"This circumvents the possible need for elective termination" of pregnancy, Verlinsky said this week at the annual meeting of the American Society of Human Genetics in Baltimore. He predicts the technique will prove useful for a variety of recessive inherited defects such as cystic fibrosis, muscular dystrophy and Tay-Sachs disease. These diseases cause essentially no symptoms in individuals carrying only one defective gene but can kill when defective genes are inherited from both parents. In theory, Verlinsky's technique would ensure that a child would not inherit a defective gene from both parents.

Although the procedure is time consuming and costly – adding at least $5,000 to the current $10,000 price tag for a single, standard attempt at *in vitro* fertilization – it has already stirred considerable interest among women who could benefit, the researchers say.

In related research presented at the meeting, Diana W. Bianchi of the Children's Hospital in Boston reported progress toward a method of performing genetic tests on fetal red blood cells that have leaked through the placenta into the mother's circulation. Such leaks apparently occur after about 10 weeks' gestation. The procedure, which remains experimental, requires only a blood sample from the mother's arm, making it far less invasive than amniocentesis or chorionic villus sampling. – *R. Weiss*