News of Science

Expanding Universe

The theory of the expansion of the universe rests observationally on Hubble's law, which shows that galaxies in space are receding from each other with velocities that are proportional to their distances apart. Evidence for this red-shift law rests on observations obtained only in the narrow visible portion of the wide electromagnetic radiation spectrum that impinges on the earth's atmosphere.

The observed red shifts of the optical lines have been interpreted as the result of a true recessional velocity, the shift arising through the well-known Doppler effect. Alternate explanations of the red shift have been advanced which would not require motions in the universe; as Finlay Freundlich has proposed, the spectral shift might be the result of a possible photon-photon reaction, whose red shift would depend on the path length and radiation field traversed by the quanta. From debates such as those raised by Freundlich, and because of the importance of the Doppler interpretation in cosmologies, astronomers, cosmologists, and physicists have considered the possibility of additional independent "tests" that would either support or cast doubt on the Doppler interpretation.

Such a test for the Doppler interpretation would be a red-shift measurement on an extragalactic object, using radiation of a wavelength that is significantly different from the optical wavelengths. If the observed red shift is the result of a real recession of extragalactic objects, the wavelength shift divided by the wavelength used should be constant anywhere in the electromagnetic spectrum.

The spectral line at a wavelength of 21 cm, which arises from hydrogen gas in the interstellar medium, offered such a test for the Doppler interpretation. Its detection by Ewen and Purcell at Harvard University in 1951 was one of the most important landmarks in radio astronomy. The emission line at the 21-cm wavelength comes from vast hydrogen clouds that are a part of the Milky Way.

This emission line is caused by a hyperfine transition in ground level of the hydrogen atom. Normally the line appears in emission, and studies of the intensity and Doppler shift by Dutch, Australian, British, and American radio astronomers have led to an enlightened picture of the dynamics of the Milky Way.

The hydrogen line may also appear as an absorption line if it is viewed against a sufficiently bright background such as a discrete radio source or radio star. The work at the Naval Research Laboratory has been primarily concerned with the absorption effect in the spectra of radio stars and has revealed previously unsuspected fine structure in the distribution of the hydrogen gas in the Milky Way. In addition, it has been possible to determine the distance to a number of the radio sources.

The identification by Baade and Minkowski of the Cygnus A radio source as a pair of colliding galaxies not unlike the Milky Way raised the possibility of detecting the hydrogen gas present in these galaxies in absorption against the hot region where the galaxies are in collisional contact. The two galaxies are at a distance of approximately 100 million light-years and were found by Baade and Minkowski to be receding at a velocity of 16,800 km/sec. If the recessional velocity, or red shift, were real and due to a Doppler shift of the optical emission lines, the same proportional shift would be present in the 21-cm hydrogen absorption line, and it should appear at a longer wavelength.

On this basis the spectrum of Cygnus A was studied by A. E. Lilley and E. F. McClain of the Naval Research Laboratory, and a weak hydrogen absorption line was detected at a wavelength corresponding to a recessional velocity of 16,700 km/sec.

In making the measurements a second nearby radio star Cassiopeia A, was used as a standard against which Cygnus A was compared. This had the effect of increasing the precision of the measurements by an order of magnitude.

With the hydrogen absorption measurements on the Cygnus source, Lilley and McClain have shown the constancy of the red shift over a base-line of 500,000 to 1 in the electromagnetic spectrum. This constancy is a natural consequence of the Doppler interpretation, giving this interpretation strong support. These results now impose the constancy requirement on any alternative explanation. This work was reported at the recent meeting of the AAAS in Atlanta, Ga.

Saltonstall-Kennedy Report

Nearly half of the $3 million provided for the U.S. Fish and Wildlife Service by the Saltonstall-Kennedy Act for the year ending 30 June 1955 was used for biological research on fish and fisheries, according to a report that has been issued by Acting Secretary of the Interior Clarence A. Davis. A total of $1,434,000 was expended on these studies. Approximately the same amount—$1,444,000—was spent for research in the exploration, development, and utilization of our fishery resources. About $92,000 was allotted to general administrative expenses and $30,000 to construction.

The Saltonstall-Kennedy Act was passed in 1954, amending existing statutes. It provides funds "to promote the free flow of domestically produced fishery products in commerce by conducting a fishery educational service and fishery technological, biological and related programs—and to develop increased markets for fishery products of domestic origin. . . ."

In carrying out this policy, the Interior Department has let about 60 contracts for research work in every section of the country for more than 40 percent of the year's funds. The contractors include 30 universities, colleges, and public institutions, and 13 commercial and independent scientific research organizations. These contracts represent in excess of $1,250,000.

More than 100 projects, representing a potential expenditure of more than $10 million have been suggested for study under the Saltonstall-Kennedy funds. An advisory committee named by the Secretary of the Interior advises in preparing rules and regulations and in recommending priority of projects.

NSF Survey of Industrial Research

Industrial research and development effort in the United States cost $3.7 billion in 1953 and required the employment of nearly 30 percent of all scientists and engineers in industry, according to a study conducted by the Bureau of Labor Statistics for the National Science Foundation. The report, *Science and Engineering in American Industry—Preliminary Report of a Survey of Research and Development Costs and Personnel in 1953–54,* is based on a questionnaire survey of a sample of approximately 11,600 companies carefully selected as representative of American industry. Alan T. Waterman, director of NSF, says of the report:

"The gratifying response from nearly 90 percent of the companies surveyed shows clearly the increasing emphasis industry is placing on research and de-