fication in the shell of ζ Tauri, and that the shell rotates with a speed about 250 km/sec.

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van de Hulst, H. C. Observations of the interstellar hydrogen line of wave length 21 cm made at Kootwijk, Netherlands.

The change of energy effected in the ground state of a hydrogen atom by reversing the electron spin relative to the proton spin corresponds to a frequency of 1420.4 Mc/sec, or a wave length of 21 cm. This line may be emitted by magnetic dipole radiation. The computed life time of the upper level, i.e. the inverse transition probability, is 11 million years. The discovery of this line as an emission line from interstellar space was made by Ewen on March 25, 1951, about seven years after its prediction. It was confirmed on May 11 by Mr. C. A. Muller of the Radio Astronomy Research Group in the Netherlands. A later confirmation was obtained early in July by Christiansen and Hindman of the Australian group.

The Dutch measurements were made with a movable mirror of 7 meter diameter and $2^{\circ}8'$ beam width. Scans were made across the Milky Way at many longitudes with continuous switching from a frequency in the line to a frequency outside it. The intensity on the galactic equator in Cygnus is somewhat larger than in the direction towards the galactic center. Half the maximum intensity is reached at latitudes $\pm 4^{\circ}$ to 8° , depending on longitude. The large width in latitude suggests that the emission comes from relatively nearby clouds, which is confirmed by a computation of opacity depth based on assumed values of the transition probability, temperature and density. The shape of the line toward the center ($l = 325^{\circ}$) is symmetrical and yields an average cloud velocity of 5 km/sec in one coordinate. At $l = 355^{\circ}$ the line is broadened by galactic rotation. A scan across the Milky Way at that longitude and at a frequency 250 kc/sec below normal, i.e. in the wing of the line, gave a much sharper drop of intensity with latitude, showing that more distant parts of the galaxy are observed.

The importance of this discovery for investigations of galactic structure is very great. The Doppler displacement will reveal for the first time the rotation of the inner parts of our galaxy, which are hidden from sight by obscuring clouds. And the vast regions of interstellar space where hydrogen is neutral become for the first time

accessible to observation. A full survey will require three-dimensional scanning, in longitude, latitude and frequency. The equipment at Kootwijk is now disassembled for improvements.

More details of these results are described in a letter to *Nature*.

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Whipple, Fred L. The Baker super-Schmidt meteor cameras.

The first super-Schmidt meteor camera, designed by Dr. James G. Baker, manufactured by the Perkin-Elmer Corporation and purchased by the U. S. Naval Bureau of Ordnance, was tested at Norwalk, Connecticut in late May. The camera was flown to New Mexico where it is now installed and in operation at the Soledad Station of the New Mexico meteor-observing stations, approximately 12 miles east of Las Cruces, New Mexico. The camera has a numerical aperture $12\frac{1}{4}$ inches, focal length 8 inches, optical focal ratio F/0.65 and effective focal ratio F/0.82. Its field is 55° with almost no vignetting. The rotating shutter covers 52° .

The preliminary tests showed that the image quality is excellent over an area of diameter 40° , the diameters of the photographic images of faint objects being of the order of 25-30 microns. At the edge of the field, some $27\frac{1}{2}^{\circ}$ from the optical axis, the image quality is still reasonably good, the diameters becoming approximately twice those nearer the center of the field. More than 80 per cent of the light is concentrated within these measured diameters.

A rotating shutter is mounted inside the correcting shell, approximately 2 mm from the surface of the film, reducing the total field diameter to 52° for meteor photography. Since it is difficult to hold the film accurately to the surface of the film holder in the outer $\frac{3}{16}$ inch of the radius, no effective loss is introduced by this restriction on shutter dimensions. The shutter occults at intervals of $1/3600$ second and is open one quarter of the time. The effective exposure times on a clear moonless sky with a rotating shutter will be approximately 15 minutes on films selected for maximum sensitivity at exposure times of the order of $1/1000$ of a second.

Because of the sensitivity of image quality to focus, the system is quite sensitive to temperature changes. The best solution appears to be a thermostatic temperature control of the entire camera.

From preliminary tests made in June 1951, the