Observations at Cambridge

At the recent meeting in Sydney of the International Union of Scientific Radio, reports were given of three separate experiments designed to measure the angular diameter of radio stars by the use of interferometers of large resolving power. Two of the experiments, by Hanbury Brown and by Mills, have been extended and are the subject of the present communication. The third, carried out at Cambridge in the first half of this year, has been described elsewhere[1]; since a rather different range of apertures was used in this experiment, it is thought appropriate to describe the results briefly for comparison with the other accounts.

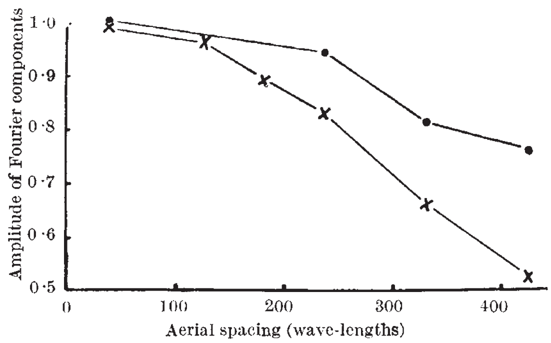
It was first pointed out by McCready, Pawsey and Payne-Scott[2] that interferometer aerials could be used to determine the angular distribution of radio 'brightness' across a source of radio waves. They showed that this distribution could be resolved into Fourier components by the use of different aerial spacings. The application of this principle to the determination of the distribution of radio brightness across the sun has already been described[3,4]; it was shown that a determination of the complete variation of the amplitude of a recorded signal as the aerial spacing was changed allowed the radial distribution of a circular source to be derived.

Similar observations have been made in an attempt to determine the distribution of brightness across the intense radio stars in the constellations of Cygnus and Cassiopeia. Owing to the smaller angular diameter of these sources, it was necessary to determine the amplitudes for the smaller spacings with considerable accuracy. It was not possible to determine the whole amplitude spacing curve with the maximum aerial separation available; the fine structure in the distribution of radio brightness across the source could not, therefore, be determined.

In these observations, which were made at a wave-length of 1·4 m., the phase-switching method of detection[5] was used with aerials spaced along an east–west line up to distances of 400 wave-lengths. This method of detection allows the use of pre-amplifiers at the aerials and, therefore, enables large spacings to be used without difficulties due to the attenuation in the transmission lines. In order to avoid the necessity for long-term stabilization of the gain of a movable aerial system, a new system of observation was devised in which measurements were made of the ratio of the amplitudes of the records obtained with two different aerial spacings. These two spacings were obtained by using the movable aerial alternatively with two fixed aerials, and it was then no longer necessary for its gain to remain constant. Each observation then provides a measure of the ratio of two Fourier terms; although it was not possible to derive the separate Fourier components uniquely from the results of these experiments, a fair approximation to the actual curve of Fourier components could be derived. The results obtained by this method are therefore comparable with those obtained in the two other methods; and although the present method cannot conveniently be used to make measurements at very great apertures, it has advantages for determining the Fourier terms related to the larger-scale structure of the brightness distribution.

MEASURED RATIO OF FOURIER COMPONENTS

Aerial spacing in wave-lengths		Cygnus	Cassiopeia
37	423	0·79 ± 0·05	0·52 ± 0·05
131	330	0·83 ± 0·02	0·70 ± 0·02
36	234	0·94 ± 0·03	0·84 ± 0·02
13	186	—	0·92 ± 0·03
75	124	—	0·97 ± 0·02



Measured Fourier components of the distribution of radio 'brightness' across the radio stars in Cygnus and Cassiopeia

The results of the Cambridge observations on the radio stars in Cygnus and Cassiopeia are shown in the accompanying table.

A possible interpretation in terms of Fourier components is shown in the diagram.

The measurements are consistent with those to be expected from a uniformly bright disk of 3·5′ diameter for Cygnus, and 5·5′ diameter for Cassiopeia. The measurements at larger resolving powers reported at the Sydney meeting of the International Union of Scientific Radio by Hanbury Brown and by Mills showed that there is also some structure of smaller angular width, and that there might be some considerable departure from circular symmetry. It is of interest to compare these results with those that might be expected from the visible nebulæ which have been identified with those two radio stars (Baade and Minkowski, in course of publication).

The Cygnus nebula is extragalactic. It has a central concentration about ¾′ of arc across, surrounded by a more diffuse region. The nebula is faint, so that it is difficult to estimate the extent of this region, but it is at least 2′ of arc in diameter.

The Cassiopeia nebula is a gaseous nebula in which the brightness is distributed unevenly over a roughly circular region about 5′ of arc in diameter. There are some particularly bright regions concentrated in an area extending 2′ of arc east–west and 1′ of arc north–south.

It appears that the radio measurements are in good agreement with the brightness distributions which might be expected from these nebulæ; this conclusion further strengthens the evidence for their identification with the two radio stars.

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