PAPER 31

APPARENT INTENSITY VARIATIONS OF THE RADIO SOURCE HYDRA A*

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During the course of a survey for radio sources using a sea interferometer changes in the apparent intensity of the source Hydra A were observed. The intensities on two consecutive days differed by more than 30 % although the intensities of sources appearing earlier and later on the same records showed no significant changes. The position of this source given by Mills (1952) [2] is R.A. $09^h\ 15^m\ 46^s$, dec. $-11°\ 55'$ (epoch 1950) and its I.A.U. number 09S1A.

In April 1954 the survey was completed and a systematic study of this source using the 110 Mc./s. sea interferometer was undertaken by O. B. Slee. The source was observed at its rising above the eastern sea horizon and control observations were made of at least one of the sources Taurus A, Virgo A, Centaurus A and Fornax A within a few hours. In this way the intensity measurements of the Hydra source were largely freed from the effects of calibration errors. The daily measured intensities of Hydra A and a comparison source are shown in Fig. 1 *a* for the period April to December 1954. Here the comparison source is a composite, obtained by bringing the intensity measurements of the Taurus, Virgo, Centaurus and Fornax sources to a common scale; this procedure was necessary as normally only one comparison source was observed at any particular time of the year.

From December 1954 to July 1955 the Hydra source, together with the three comparison sources in Taurus, Virgo and Centaurus, was recorded almost daily during meridian transit, using the east–west arm of the 85 Mc./s. 'cross'-aerial (Mills, Little and Sheridan, in preparation [3]). This arm of the cross has a fan-shaped response pattern, $0\overset{\circ}{.}6$ east–west and 50° north–south, between half-power points. The measured intensities of the Hydra source and the comparison source in Virgo for the period December to July 1955 are shown in Fig. 1 *b*.

* A full account is published in the *Aust. J. Phys.* [1].

From both the sea interferometer and the cross observations it can be seen that the variations in the intensity of the Hydra source are far greater than those of the comparison sources. This is also illustrated in the histograms of Fig. 2, where it is shown that essentially the same results were obtained on both instruments.

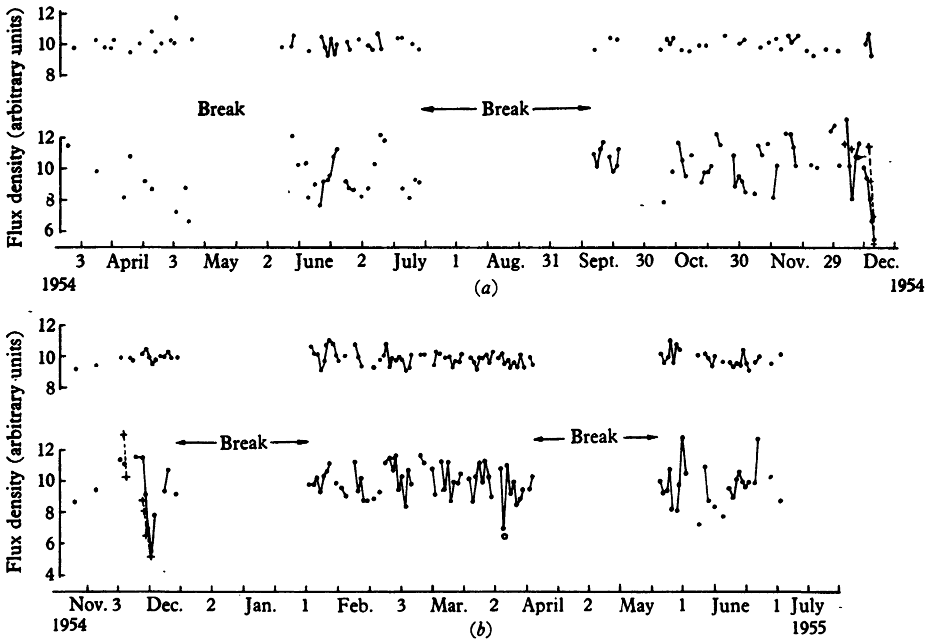

Fig. 1. Plots of the daily observed intensities of Hydra A and the comparison sources. All sources have been brought to a common arbitrary intensity scale of mean value 10 units. 1 *a* and 1 *b* refer to the rising and transit observations respectively. The upper diagram in each figure shows the results for the comparison source, and the lower for Hydra A. The open circle of 1 *b* refers to an interferometer measurement. The crosses plotted in December represent values transferred from the other series of measurements during the overlap of observations.

Two possible sources of error were investigated. In both series of observations the suspected variable was compared with sources which were of higher signal-to-noise ratio at the receiver input except for Fornax A in the sea interferometer observations and Taurus A in the transit series. It might be expected that the lower signal-to-noise ratio would produce a large scatter in the Hydra A intensities. The transit observations were therefore subjected to a statistical analysis in which it was found that standard deviations of the three comparison sources were very similar despite large differences in the signal-to-receiver noise fluctuation ratios. From this it was concluded that the noise fluctuation level was not high enough seriously to affect the accuracy of the intensity measurements on any of the source. A further possible source of error in the sea interferometer observations resulted from the difficulty of estimating intensities in the presence of scintillations. However, no correlation was found between the estimated intensities and the scintillation index.

From Fig. 1 it can be seen that the correlation between intensity variations recorded on both instruments during the overlap period in December 1954 is very good. Good correlation was also obtained between 'cross'

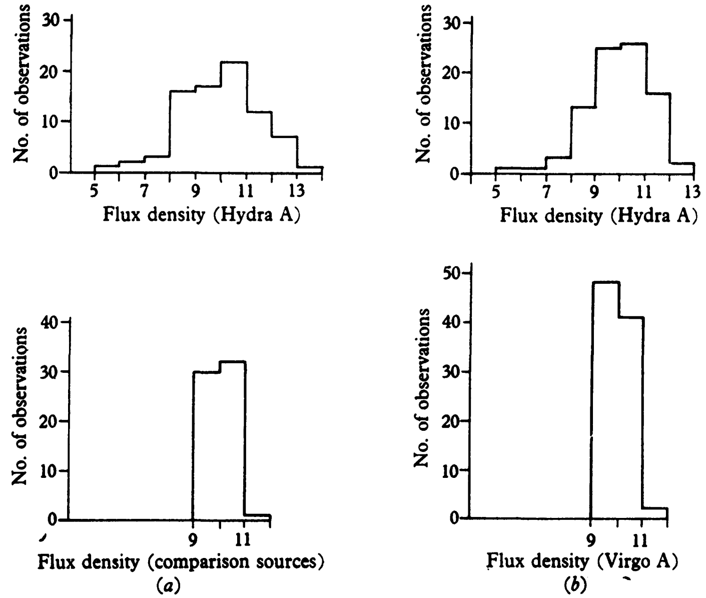

Fig. 2. Histograms showing the distributions of intensities for Hydra A and the comparison sources. (*a*) and (*b*) refer to the rising and transit observations respectively.

observations on occasions during April, May and June 1955 and observations made by Carter (unpublished work) using an interferometer operating at 100 Mc./s. with a baseline of either 90 or 1000 wave-lengths. With this instrument three very significant reductions amounting to as much as 70 % of the mean intensity have been observed, one of which was also observed with the 'cross'.

Taking all the observations together, a fairly strong case has been made out for the variability of the Hydra source. The variations do not appear to have any marked periodicity but are random from day to day. No marked changes have occurred during the period of observation with single instruments, and in some cases there is agreement between observations with two instruments 6 hr. apart. The average 'fading time' appears to be between 6 and 24 hr.

The origin of the observed intensity variations may be in the source or in the intervening medium. An identification of the source may help to decide which is the more likely possibility. The radio position obtained by Mills from the 85 Mc./s. 'cross' (unpublished) is R.A. $09^h\ 15^m\ 40^s \pm 4$, dec. $-11^\circ\ 52'.5 \pm 2'$ (1950) which is practically coincident with a faint galaxy which has been photographed by Baade, and its spectrum obtained by Minkowski with the 200-inch telescope (personal communication). Although the galaxy has a double nucleus there are no spectrum abnormalities to suggest a possible collision as in the case of Cygnus. Unpublished measurements by Carter suggest a size for the source of about $1'.5$ between half-brightness points in the east–west direction which is consistent with the optical dimensions of the galaxy. If the identification is correct it is unlikely that the variations of such short period originate in such a large object. The physical dimensions of the source would be unlikely to exceed the distance a light signal could be propagated across it in a time of the order of the fading time. If the identification with the galaxy is neglected and the above argument is taken in conjunction with the angular size of $1'.5$ the source must be within a few parsecs of the sun.

If the variations are impressed between the source and the earth, these could occur in ionized regions in interstellar space or in the ionosphere. As the variations are not seen on a source of comparable angular size (Cygnus) the latter seems unlikely. If the former is the case one possible mechanism for the fading would be the rotation of the plane of polarization due to the Faraday effect in an ionized region with a magnetic field. However, to produce variations in intensity of the observed extent the source would have to be at least 50 % plane polarized; this should be easy to detect.

During the course of the transit observations a second possible variable source was found. Owing to the low resolving power of the aerial in the north–south direction, no reliable estimate of the declination of this object can be given; its R.A. is approximately $10^h\ 05^m \pm 5^m$. The apparent variations in the intensity of this source are much larger than that of the Hydra source; they take the form of occasional jumps to as much as three times the normal intensity for a period of a day or two. However, in the absence of a reliable position and confirming evidence from other instruments, the reality of this phenomenon must be questioned.

REFERENCES

[1] Slee, O. B. *Aust. J. Phys.* **8**, 487, 1955.
[2] Mills, B. Y. *Aust. J. Sci. Res.* A, **5**, 266, 1952.
[3] Mills, B. Y., Little, A. G. and Sheridan, K. V. (in preparation). 'A high resolution radio telescope for use at a wave-length of 3·5 metres.'

Discussion

Smith: Can part of the variation be due to scintillation?

Bolton: The scintillation index was found to be the same for the Hydra and Virgo sources and no correlation was found between scintillations and variability of Hydra.