FREE DISCUSSION ON GALAXY

Oort: I should like to have another discussion on the problems of the polarization observed in the Galactic System, as there was not enough time for discussion when these observations were presented last week.

In the observations of polarization of the radio-frequency radiation we are faced with entirely new problems which we do not understand. As Professor Westerhout pointed out, the polarizations are generally small, but there are a small number of regions where fairly large polarizations occur. These regions are quite small, except the one centred at $l^{II} = 142°$, $b^{II} = 8°$, which extends over about 20° by 15° and shows a remarkable pattern of the directions of the electric vector.

The character of the magnetic field observed in these instances is in remarkable contrast with that which is found from the observations of optical polarization, where considerable irregularity is found in large parts of spiral arms.

Bolton: It should be worth while looking at a lower frequency than those so far used because the spectrum suggested by Gardner and Roberts in an earlier paper is rather steep. I suggest 200 Mc/s.

Oort: We plan to make a survey at 600 Mc/s, but I agree that lower frequency measures would be equally useful.

Mathewson: In regions around the Small Magellanic Cloud and extending far to the north, Healey, Milne, and myself have found a linearly polarized component of the radio emission using the 210-foot reflector at 408 Mc/s. The diagram shows roughly the area near the south galactic pole where this polarized radiation was found.

Spectral index measurements of the polarized component were made at one of the strongest regions (01^h11^m, $-64°30'$). This gave a flux-density spectral index of zero in great contrast to the *very* "steep" spectral index that Dr. Gardner and Dr. Roberts found in the "Dutch" region.

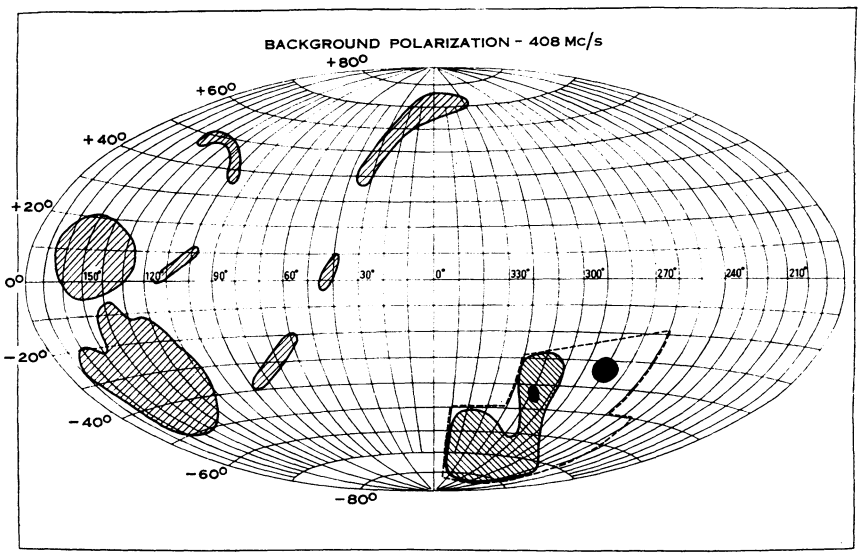
Kerr: Has anyone looked for radio polarization effects in M31 or any other normal galaxy?

Roberts: In reply to Mathewson: observations of Gardner, Roberts, and Little have shown a steep spectrum ($T \propto f^{-3.5}$ to $f^{-4.5}$) in parts of the region near $l^{II} = 150°$, $b^{II} = -50°$, where polarization was found by the Dutch observers. However, in other parts of this region, and in the region near $l^{II} = 0°$, $b^{II} = 65°$, the spectrum is more normal.

Visvanathan: In the past few months, Mount Stromlo Observatory has been engaged upon the design and construction of a double-channel polarimeter. This is expected to be set up by the end of this month. This will mainly be used at the Cassegrain focus of the 40- and 50-inch telescopes. It is proposed to observe the wavelength dependence of polarizations and extinction from the u.v. to the infrared of stars both in our Galaxy and in the Magellanic Clouds.

A single-channel photoelectric polarimeter was set up with the rotatable polarimeter as analyser. With this instrument 12 stars in the LMC and 8 in the SMC were observed for interstellar polarization. The position angle of the angle of polarization of all the stars shows a striking parallelism with the bars of the Clouds. The polarization is generally $<2\%$, although there are a few cases where we see polarization as high as 5%. The ratio of extinction to polarization is very high compared to our Galaxy and M31.

Bok: The results quoted by Mr. Visvanathan are still highly preliminary, but they do set an upper limit to the polarizations in the Magellanic Clouds. The results obtained by the Oxford expedition to the Andes are not confirmed.



The shaded areas to the left of $l^{II} = 0°$ represent the regions of sky where the Dutch have detected linear polarization at 400 Mc/s. The shaded area to the right of $l^{II} = 0°$ represents the region in which linear polarization has been detected with the 210-foot reflector at Parkes at 408 Mc/s. The dotted line indicates the extent of the survey so far.

Feast: I am puzzled by Professor Bok's statement that the Mount Stromlo work on the polarization of some of the brighter star members of the Magellanic Clouds disproves the polarization values found by the Oxford expedition for the integrated light from the Clouds. The Oxford results are extremely puzzling, but refer after all to a quite different stellar component of the Clouds from the studies at Mount Stromlo.

Bok: I beg to disagree. Photographs of the Large Cloud taken through polarization filters do not show the high percentage polarization reported by the Oxford group. Furthermore, Visvanathan's stars are fairly well scattered over the Clouds.

Hopper: It was stated in the morning paper by Parijsky that the centre of the Galaxy was a source of acceleration of cosmic ray particles. Have experiments been performed, or are they being planned, to observe high energy photons from

the galactic centre? The photons would not be deflected by interplanetary fields, but would need to be studied from directed telescopes on satellites or high altitude balloons. I would like the view expressed as to whether such experiments would be worth while.

Aller: Measurements of cosmic rays — even outside the terrestrial magnetosphere — are difficult to interpret because of turbulent, variable magnetic fields in the solar system itself. X-ray measurements will be made outside the Earth's atmosphere in special experiments flown in satellites, but no results on emissions from the galactic bulge are available yet.

Burke: Clarke and Rossi have observed, in a satellite, approximately 70 or 80 gamma ray counts, distributed isotropically over the sky with no significant clustering. An earlier experiment of theirs using their large counter array, looking at showers of high energy, and involving over a thousand counts, likewise showed no significant deviation from isotropic distribution.

Thackeray: I would like to hear a discussion on some of the nebulae investigated by Dr. Courtès. From his diagram there appeared to be some nebulae very close to the direction of the galactic centre, but with velocities running up to 40 km/sec or even more. Where do you regard these as placed in distance?

Courtès: If I have understood your question, you are surprised to find that the HII regions in the direction of the centre have not a velocity of 0 km/sec. The nebulae measured are as near as possible in the direction of the Sagittarius A source, and some astronomers have believed that these nebulae were really connected with the very central core. The morphology of E13 (in spite of the small chance of having this coincidence in direction) does not suggest a very distant HII region, but the test was to measure the radial velocity. We have obtained radial velocities +13 to +31 km/sec for E13, E16, etc. This result is in good agreement with those of neighbouring HII regions along the galactic equator, and this group of nebulae certainly appears to be part of one of the inner arms, but not of the central core. The fact that we have obtained positive velocities between +13 and +31 km/sec does not necessarily mean that we have not a circular motion, but other measures along the galactic equator will give better confirmation of the presence of non-circular motion.

Parijsky: (1) As far as polarization in the Galaxy is concerned, it may be of interest to report that observations at Pulkovo give strong support to the very small scale of the Faraday rotation. The percentage of polarization decreases with frequency simultaneously at every point in the Crab nebula. This means that the scale must be smaller than 1′, the resolution of the radio telescope (Soboleva, N.S., *et al.*, *Astr. Zhurn. USSR* (1963)). In the case of Cygnus A this scale must be smaller than 15″ (Soboleva, N.S., *et al.*, *Astr. Zhurn. USSR* (1963) (in press)).

(2) We tried to separate the interplanetary Faraday rotation from that in the Galaxy by observation of the occultation of the Crab nebula by the solar corona in polarized radiation at 6·4 cm. The variation of the position angle does not exceed 8° (Parijsky, Y.N., Soboleva, N.S., and Golnev, V., *Astr. Zhurn. USSR* (1963) (in press).

(3) In some sources we may give another explanation of the rapid decrease of the percentage of polarization. In the Cygnus A source we have an indication

of the rotation with frequency of the position angle of the line joining the two components (Parijsky, Y.N., *et al.*, *Astr. Zhurn. USSR* (1963) (in press)). Thus the regions emitting at different frequencies may be separated in space.

Milne: I would like to add to Dr. Parijsky's comments on Cygnus A. I have been observing the Vela X supernova remnants at 11 and 20 cm with the Parkes telescope. The polarization is not as extensive as the brightness contours, and little or no rotation is observed between 20 cm and 11 cm. However, there is much smoothing of the polarization at 20 cm relative to the 11-cm measures owing to severe spatial rotation of the vector in the increased beamwidth. The maximum polarization at 11 cm is about 20%.

Gardner: Dr. Parijsky mentioned the possibility of galactic depolarization for the Crab nebula and for Cygnus A. Our measurements on a number of other radio sources have shown that the rate at which the degree of polarization decreases at longer wavelengths does increase near the galactic equator. With the limited sample, there is the possibility of the result being affected by the source selection, as, in the sample, there is a preponderance of sources with high surface brightness towards the plane. Galactic depolarization, if genuine, does imply very fine structure in magnetic field or electron density across sources, typically 1 min arc in extent; for a small net Faraday rotation reversals of magnetic field directions along the line of sight are implied.