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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part III

III-3-6. Propagation of Cosmic Rays in Galactic Arm

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It is so far well accepted that the solar system is located within or near the boundary of an arm of Galactic spiral structure. The structure which is concluded by means of observation of radio of 21 cm wave length is likely as shown in Fig. 1. Also, more or less regular magnetic flux is presumed along these arms.

What we wish to mention here is a few of experimental information which appears to us to have something to do with this magnetic structure of the Galaxy.

The first, in the anisotropy of EAS which we and the group of Osaka City University seem to have found with regard to EAS initiated by heavy primaries and also which MIT people have found for extremely large EAS. Although we know that we have to be very cautious to accept this anisotropy, we think that it is at least worthwhile to try to work out a hypothetical consideration. The anisotropy agrees well with the perpendicular direction to the Orion arm of the Galaxy and this anisotropy has been explained in terms of the magnetic field in the arm in the preceding report.

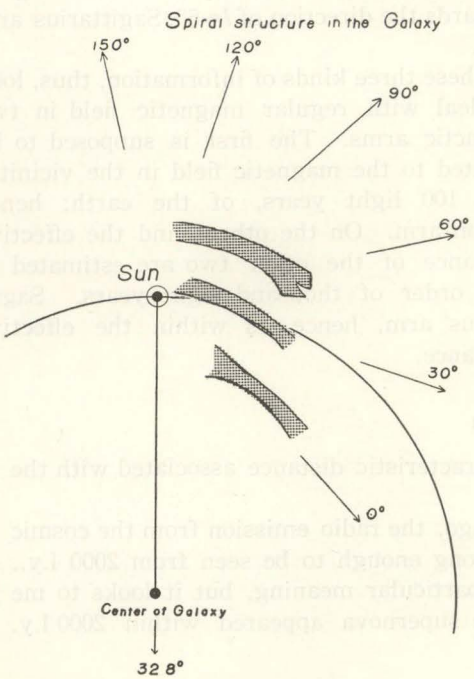

Fig. 1.

The second information comes from the polarization of the starlight. The data is from the article by Dr. Hiltner. Short lines on Fig. 2 show the direction of polarization of starlight. The features of convergence around $l \approx 5°$ and parallelism to the Galactic equator seen between $l \approx 70°$ to $l \approx 140°$ are very impressive. If we admit the theory that the direction of this polarization is in parallel with the direction of magnetic field in the space between the star and us, this seems to show the arm goes towards $l \approx 5°$.

The third regards the supernova. Let us suppose some time after the explosion of a supernova and let us follow the picture of Ginzburg and Hayakawa and others that cosmic ray particles of fairly high energies are accelerated in the envelope of the supernova and being ejected during thousand years after the explosion. The total number of particles may be of the order of 10^{51} particles, average energy being the order of 10^{10} eV.

It may be quite natural to suppose that this sort of cosmic ray gas occupies a cigar-shaped region, of course the boundary of which does not have to be clear, along the regular magnetic field. Presuming that the length of this "cigar" may increase by probably 1/3 of the light velocity, we can estimate intensity of the synchrotron radiation from this region.

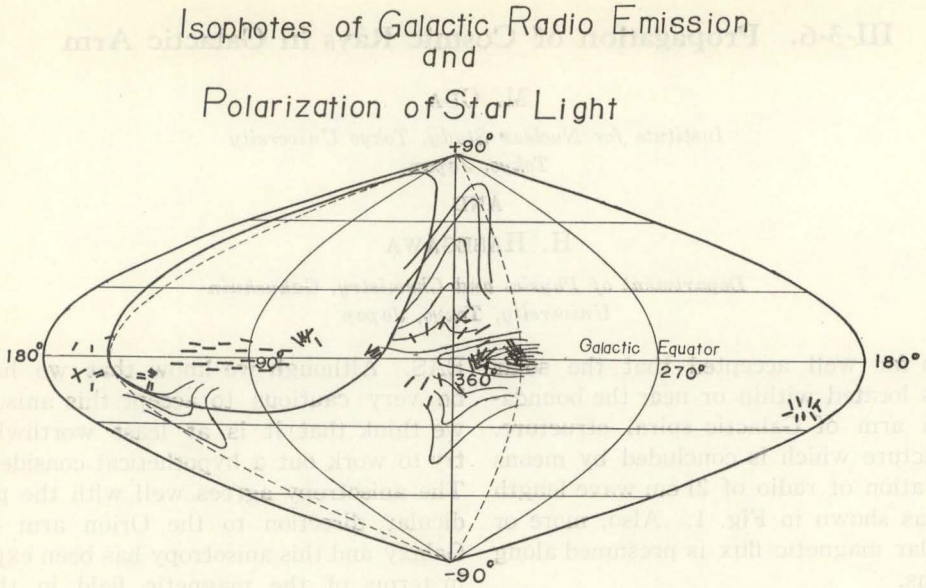

Fig. 2.

If the Galactic latitude of the supernova is low, this radio emission is not distinguishable from the general radio background from the Galactic equator and only the remnant of the supernova is seen as the point-radio-source, which we wish to emphasize to be different from what we are discussing now.

If the Galactic latitude of supernova is not low, we might see the cigar-shaped-shiny cloud against the background of the Galactic halo. Actually if we assume a reasonable distance like 2000 l.y. and reasonable period after the explosion of the supernova like 2000 years we get the intensity of radio from its direction to be more than several times as large as from the background of the halo.

There is a definitely a belt of tongue-shaped region on the isophotos map of Galactic radio emission. There have been a couple of trial of explanation without much success. It seems to us that this might be from the above mechanism. If so, the belt should intersect the Galactic equator at the direction of the magnetic flux in which the cigar is embedded. It shows an excellent agreement with the information from starlight, and the both show the direction $l \approx 5°$. We wish to remind you that, as seen in Fig. 1, towards the direction of $l \approx 5°$, Sagittarius arm lies.

These three kinds of information, thus, look to deal with regular magnetic field in two Galactic arms. The first is supposed to be related to the magnetic field in the vicinity, say 100 light years, of the earth: hence Orion arm. On the other hand the effective distance of the other two are estimated as the order of thousand light years. Sagittarius arm, hence, is within the effective distance.

Discussion

Burbidge, G. R.: How do you derive the characteristic distance associated with the radio feature?

Oda, M.: If supernova exploded 3000 years ago, the radio emission from the cosmic ray particle cloud from the supernova is strong enough to be seen from 2000 l.y.. The value of 2000 l.y. itself does not have a particular meaning, but it looks to me quite reasonable to suppose that more than one supernova appeared within 2000 l.y. within 3000 years in the past.