COSMIC RAYS AND GALACTIC RADIO NOISE

G. Sironi and G. De Amici
Laboratorio LFCTR/CNR and Istituto di Scienze Fisiche
dell'Universita' - Milano - Italy

Size and shape of the "confinement volume V_0", the region around our Galaxy where the c.r. particles live until they escape or loose completely their energy are essential parameters of models for the origin and propagation of the cosmic rays. Focussing the attention on the c.r. electrons, whose sources are definitely galactic and concentrated in the Disk, to confine V_0 to the Disk or extend it to the Halo is full of consequences. For instance in the first case the sources can be everywhere inside V_0; by contrast in a Halo model the sources can reside only in some parts of V_0, the mechanisms of energy loss play different roles in different regions of the confinement volume and the particle lifetimes can be up to 100 times larger than in the Disk, (e.g. ref.1).

In the 50's Shklovskii, examining the distribution of the background radio emission, suggested that our Galaxy is surrounded by a Radio Halo produced by the synchrotron emission of c.r. electrons. Discussions on the Halo reality went on for a long time. In 1975 new evidence, based on analysis by the T-T plot method, (ref.2), of new systematic observations at VHF and UHF of the background emission was presented, (ref.3,4). Plotting against each other the sky temperatures measured at two frequencies allows to work out the frequency dependence of the anisotropic, i.e. galactic, component from the total, (galactic+extragalactic), background radiation. No precise knowledge of the zero level of the temperature scales is necessary. Between ~20 MHz and ~400 MHz the T-T plots of data obtained at various right ascensions and constant declination show typical V shapes suggesting that the frequency spectrum of the galactic radiation is steeper when looking away from the local spiral arm. Interstellar absorption is insufficient to explain this effect. Instrumental bias are also excluded because the same pattern can be obtained, (see fig.1), combining data obtained independently by different authors, using different equipments, (ref.5,6). An obvious interpretation (ref.7), is that the galactic radioemission is made of at least two components, a disk, (flat spectrum), and a halo, (steep spectrum), component.

Numerical models describing the emission of our Galaxy can be worked out following that line and agree with the observational data, (ref.3,4). In doing so it is important to remember that the radiation

G. Setti, G. Spada, and A. W. Wolfendale (eds.), Origin of Cosmic Rays, 215–216.

from particular regions of the Halo tend to appear isotropic and its contribution to the frequency spectrum deduced from the T-T plots has to be properly evaluated taking into account also absolute measurements. After 1975 radio haloes have been detected around external galaxies seen edge on, some of which similar to our Galaxy, (ref.8).

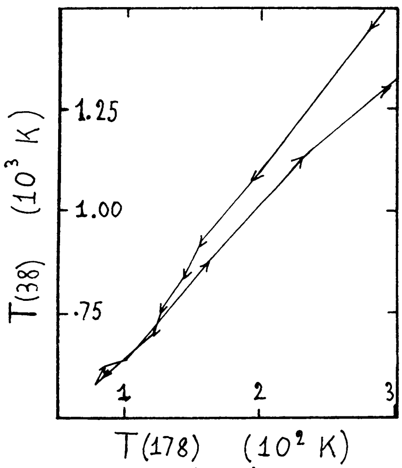

Fig.1 - (T-T)plot from 38 MHz,(ref.5),and 178 MHz (ref.6),observations smeared to 15°x15° for dec=+45 and 80°≤ r.a. ≤ 290°

We believe therefore that the existence of the Galactic Radio Halo is sufficiently well established; physical parameters, shape and dimensions of that halo are however poorly defined for a number of reasons : i)low angular resolution of the observations; it allows to easily get rid of discrete sources contribution but reduce the number of statistically independent points and masks details; ii)loops and spurs, many degrees wide, have to be removed from the maps; iii)galactic absorption, below ~20 MHz, and 3°K relict radiation, above ~600 MHz, gradually efface the Halo signature.

Many models, some of which extremely different, can therefore be reconciled with the presently available radio data. New observations are necessary. In particular we need : a)maps with angular resolution of few degrees, at various frequencies, of high galactic latitude regions of sky; aerial beam shapes and side lobes must be well known for subsequent convolution and comparison with other maps, (e.g. ref.6,9); b)accurate measurements of the absolute sky temperature toward the two minima of sky brightness and the Galactic Poles, at the same frequencies. A program of new observations covering the range 200 MHz - 2500 MHz is underway in our laboratory with ad hoc instruments and/or existing radiotelescopes, in collaboration with variou groups.

References

1)Perola G.C.,Scarsi L.,Sironi G.:1968 , Nuovo Cimento 53B , 459
2)Turtle A.J.et al.:1962 , Mon.Not.R.astr.Soc. 124 , 297
3)Gavazzi G.,Sironi G.:1975 , Rivista Nuovo Cimento 5 , 155 and references therein
4)Webster A.S.:1975 , Mon.Not.R.astr.Soc. 171 , 243 and ref.therein
5)Turtle A.J.,Baldwin J.E.:1962 , Mon.Not.R.astr.Soc. 124 , 459
6)Milogradov Turin J.,Smith F.G.:1973 , Mon.Not.R.astr.Soc. 161 , 269
7)Webster A.S.:1972 , PhD Thesis , University of Cambridge
8)Allen R.J.,Baldwin J.E.,Sancisi R.:1978 , Astron.Astrophys. 62 , 397
9)Cane H.V.:1978 , Aust.J.Phys. 31 , 561