The anisotropy of low energy cosmic rays and properties of the Local Interstellar Medium (LISM)

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Abstract: The anisotropy of arrival directions of cosmic rays less than 10^{14}ev presumably is determined by the properties of the very local interstellar medium (about 10 pc from the Sun). A number of these properties such as column density of neutral hydrogen and the characteristic of local stars have been examined and some tentative conclusions have been drawn.

1 Introduction

The origin of cosmic rays is a familiar problem. The local magnetic field has an unknown topography and its influence on the arrival direction of most cosmic ray particles is so strong that there is no connection between their sources and their arrival direction. In fact the direction of the local sources in about 1kpc could be determined using only protons with energies higher than 10^{19}ev.

Here we have considered large scale angular anisotropy for particles with lower energies about 10^{14}ev. We have at least two reasons that make this research important:

1. In this energy range particles are usually protons and we do not have to deal with the difficulties caused by the inharmonious arrival direction of particles of the same energies and different rigidities.
2. The anisotropy measurements have approximately the same phase. (However, their amplitudes do not agree as much.)

A scale ,L, in which the propagation of cosmic rays is influenced by the local interstellar medium, is determined for energies about 10^{14}ev with an assumed magnetic field about 3 μG to be about 10 times the Larmor radius (R_L=pc/300B ,B is the magnetic field and pc has energy dimension). We have considered such a region in the local interstellar medium.

In fig. 1, we have presented the universal data of the anisotropy for energies about 10^{14}ev.

Then we have considered some of the properties of the local interstellar medium such as nearest stars, the interstellar hydrogen column density from these stars and the direction and speed of the movement of LISM relative to Sun.

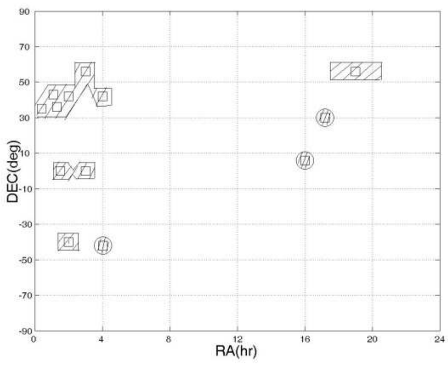

Figure 1: Region with maximum anisotropy amplitudes

2 Anisotropies of cosmic ray particles with energies about 10^{14}

The positions of anisotropies are presented in figure 1.

3 The local space parameters

3-1 Nearest stars

In figure 2, we have presented a collection of the nearest stars from the Sun (In a region less than 10pc). Those whose magnitudes are less than 6 have been specified by larger circles.

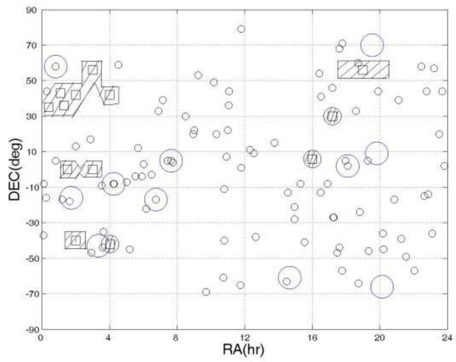

Figure 2: The nearest stars to the sun(less than 10pc) the brighter ones are mostly located in regions with maximum anisotropy amplitudes

Figure 3 shows information about the speed of nearest stars relative to the Sun specially the difference between their approaches and recessions.

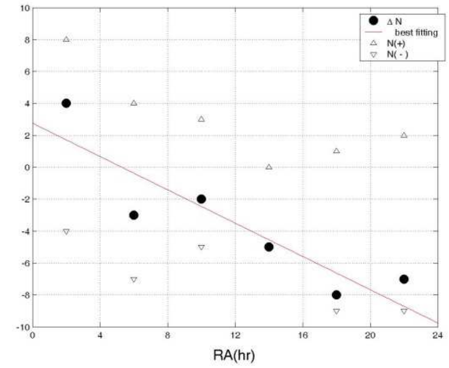

Figure 3: Stellar movement relative to the Sun (less than 10pc distant)
N (+) means recessions and N (-) means approaches. A sharp change in RA=0 is clear.

3-2 Neutral hydrogen in LISM

The atomic hydrogen column densities have been determined using reference 3. The results are shown in figure 4. As it shows there is an uncorrelated relation between anisotropy amplitudes and hydrogen column densities.

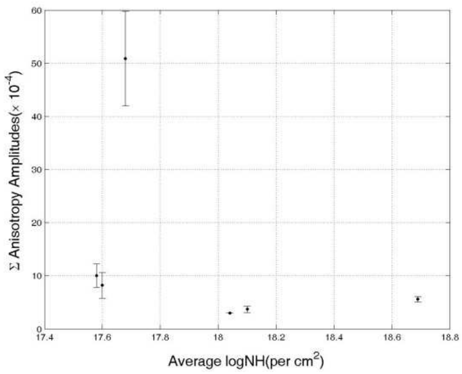

Figure 4: Correlation between anisotropy amplitudes and hydrogen column densities

4 Conclusions

From studying LISM properties, we find that LISM determines at least some of the properties of cosmic ray anisotropy with energies less than 10^{14}ev. In this way, the stars movement and hydrogen column densities are important elements. It also shows some kind of chaos in LISM caused by a change in the stars movement direction. The energy density of the stars movement is determined to be tens ev/cm^3. If we suppose that only a small fraction of this energy is transported to the ionized component of LISM, it can affect the diffusion coefficient of the cosmic rays propagation in the local interstellar medium.

References

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