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SPECTRAL TURN-OVER OF RADIO ARC FILAMENTS AT 43 GHz: Magnetic Tubes of 4000-yr Old in the Galactic Center

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1. Introduction

The origin of the straight magnetic filaments in the Radio Arc near the Galactic Center is still controversial: either if they are permanent structure of constant configuration for a galactic-time scale, or they are temporary structure of short life time such as due to a sudden injection of cosmic rays or to sudden shock compression. Measurement of life time of the radio emitting cosmic ray electrons consisting the filaments is one of the crucial methods besides a time variation measurement of the fine structure of the filaments.

In order to investigate possible spatial variation of spectral index at higher frequencies in the filaments, which might give information about the life time of cosmic ray electrons, we have performed high-resolution radio continuum observations at 43 GHz of the G0.18–0.04 region of the radio Arc near the galactic center using the Nobeyama Millimeter-wave Array. A detailed description of this work is given in Sofue et al. (1992).

2. NMA 43-GHz Observations

We used the 5-element NMA in B and C configurations. Observations were made in March and April 1991. The telescope had an angular resolution of HPBW=8.3″ × 15.3″, and the final map was convolved to 10″ × 16″ in order to increase the signal-to-noise ratio. The center frequency was 43.42 GHz, and the bandwidth 280 MHz.

3. Spectral Turn-Over and Life Time of Filaments

The straight filaments are visible at 4.7 and 15 GHz (Morris and Yusef-Zadeh 1985; Yusef-Zadeh 1986; Inoue et al. 1989). However, in the obtained NMA map at 43 GHz, the filaments are hardly seen (Fig.1). The 43-GHz emission contributes to a small fraction (<10%) of the total Arc brightness, which has been measured also at 43 GHz with the 45-m filled-aperture telescope (Sofue et al 1986, 1987). On the other hand such thermal features as the "sickle" is clearly seen at both at 4.7 and 43 GHz, showing a flat spectrum.

The radio spectrum of the nonthermal filaments has a turn-over between 4.7 and 43 GHz, most probably between 15 and 43 GHz: $\alpha < -0.7$ around 43 GHz, while it is flat at lower frequencies, $\alpha \simeq -0.2 \sim +0.1$ (Fig.2).

Assuming that the spectral turnover takes place at around 40 GHz and the magnetic field strength is of the order of 1 mG, we estimate the age of the filaments to be about 4000 years.

From this we may conclude that the filaments are transient magnetic tubes, probably produced eith by shock compression or by sudden injection of high-energy electrons approximately 4000 years ago. [See Sofue et al. (1992) for details.]

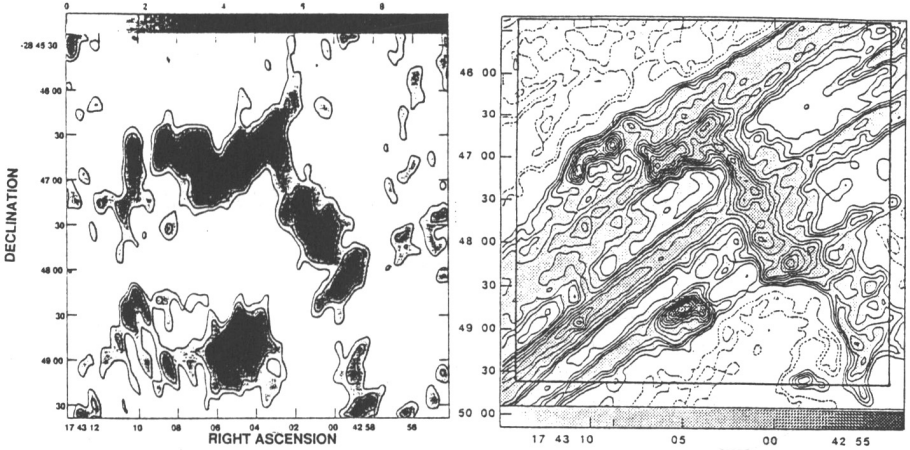

Fig.1: Left: 43-GHz (7 mm) map of the sickle (G0.18-0.04) region of the radio Arc convolved to HPBW 10″ × 16″. Right: 5-GHz (6 cm) VLA map for the same region (reproduced from Yusef-Zadeh 1986).

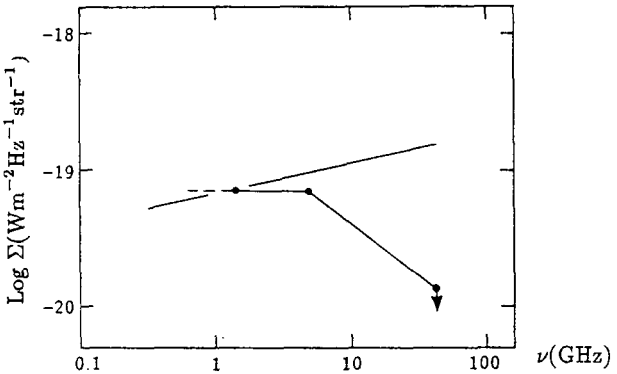

Fig.2: (a) Radio spectrum for the straight filaments near the field center; (b) Inverted flat spectrum for the mean brightness of the radio Arc.

References

Inoue, M., Fomalont, E., Tsuboi, M., Yusef-Zadeh, F., Morris, M., Tabara, H., Kato, T. 1989, in *The Center of the Galaxy*, ed. M. Morris, (Kluwer Aca. Pub., Dordrecht) p. 269.

Morris, M., Yusef-Zadeh, F. 1985, AJ, 90, 2511

Sofue, Y., Inoue, M., Handa, T., Tsuboi, M., Hirabayashi, H., Morimoto, M., Akabane, K. 1986, PASJ, 38, 483

Sofue, Y., Y. Murata, Reich, W. 1992, PASJ, 44, 367.

Sofue. Y., Reich, W., Inoue, M., Seiradakis, J. H. 1987, PASJ, 39, 359.

Yusef-Zadeh, F. 1986, Ph. D. Thesis, Columbia University, New York.