Rev. Mexicana Astron. Astrof., **21**, 504-506 (1990)

RADIO BRIGHTNESS TEMPERATURES AND ANGULAR DIMENSIONS OF RECENTLY PREDICTED VLBI SMALL-SCALE STRUCTURES

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RESUMEN. Muestro que análisis recientes publicados de fuentes de radio galácticas y extragalácticas predicen estructuras en pequeña escala en fuentes de radio extendidas, remanentes de supernova, vientos protoestelares, nubes moleculares, distorsiones del fondo de 3 K, enanas blancas magnetizadas, estrellas de tipo tardío y el Sol. Discuto las temperaturas de brillo de radio de estas estructuras y sus dimensiones. Muestro que estas estructuras son detectables con las sensibilidades actuales de VLBI (o en el futuro cercano).

ABSTRACT. I show that recently published analysis of galactic and extragalactic radio sources make predictions of small-scale structures in extended radio sources, supernovae remnants, protostellar winds, molecular clouds, distortions of the 3 K background, magnetized white dwarf binaries, late-type stars and the sun. I discuss the radio brightness temperatures of these structures and their dimensions. I show that these structures are detectable with present (or near future) VLBI sensitivities.

Key words: RADIO SOURCES-EXTENDED

I. INTRODUCTION

Radio structures have recently been discussed in: 1) extragalactic jets (Jafelice and Opher 1987, 1989; Jafelice, Opher, Assis, and Busnardo-Neto 1990; Gouveia Dal Pino and Opher 1989a,b; Medina-Tanco and Opher 1989); 2) protostellar winds (Jatenco-Pereira and Opher 1989a; Gouveia Dal Pino and Opher 1989c); 3) supernova remnants (Gouveia Dal Pino and Opher 1989d); 4) molecular clouds (Opher and Valio 1989); 5) distortions of the 3 K background (de Araujo and Opher 1988, 1989); 6) magnetized white dwarf binaries (Canalle and Opher 1988, 1989); 7) late-type stars (Jatenco-Pereira and Opher 1989b); and 8) the sun (Jatenco-Pereira and Opher 1989c). I show that these analysis predict small-scale structures that are observable by VLBI.

II. SMALL-SCALE RADIO STRUCTURES

In relation to extragalactic jets, Gouveia Dal Pino and Opher (1989a) showed for a wide range of possible jet parameters that the plasma of the jet is thermally unstable. In the region of the perturbation the electronic pressure is less than the ambient electronic pressure causing a compression of the perturbed region and an increase of its magnetic field to over twice the ambient value. This "bending-in" and change in direction of the magnetic field in filaments and knots can be traced by the polarization of the synchrotron radiation.

Gouveia Dal Pino and Opher (1989b), in another investigation, showed that apparent superluminal motion can be due to a thermal instability, rather than due to relativistic beaming. We have the resultant predictions that: a) there is a high probability for random oriented jet sources to have superluminal motion; and b) the size of superluminal knots is greater than τ_V c, where τ_V is the characteristic time variation of the radiation flux and c is the velocity of light.

Jafelice, Opher, Assis and Busnardo-Neto (1990) studied the damping of agnetosonic and surface waves in extragalactic jets and obtain a high current density at the order of the jet sufficient to confine the jet. We have the resultant prediction that urrounding the border of the jet there is a poloidal magnetic field whose pressure is ufficient to balance the internal pressure.

Jafelice and Opher (1987, 1989) showed that kinetic Alfvén waves can be important n reaccelerating electrons and produce an electric current in extragalactic jets. Jets hould have bright spots where electrons are accelerated by the kinetic Alfvén waves.

Medina-Tanco and Opher (1989) studied the general nonlinear case of oblique shock cceleration of particles in extragalactic jets and other sources. Smooth shocks are predicted o exist and in the region of these smooth shocks we should observe a change in direction of he ambient magnetic field and a brightening due to the accelerated electrons.

In relation to young and old stars, Jatenco-Pereira and Opher (1989a,b) suggested hat Alfvén waves create the observed galactic molecular and ionized outflows in young stellar bjects (YSO) and the strong winds in old giant stars (OGS). They predict a strong diverging agnetic field near the surface of YSO and OGS where mass loss occurs. Transverse velocity luctuations to the outgoing flow $\sim$ 20 km/s at a radius $r \sim 2\, r_o$ (where r_o is the radius of e stellar "surface"), with periods $0.2 - 1 \times 10^7$ sec in YSO and $10^5 - 10^6$ sec in OGS are redicted.

Gouveia Dal Pino and Opher (1989c) show that the physical conditions in the onized jets in YSO are favorable for the formation of condensations by the thermal nstability. We have the prediction that ionized jets in YSO are highly inhomogeneous and lumpy.

Jatenco-Pereira and Opher (1989c), studying the flow geometry of coronal holes in e sun, found that in order to satisfy the existing observational data, slow divergence up to height $\sim 0.01 - 0.1\, R_\odot$ is required, followed by a rapid divergence up to a height $\sim 1\, R_\odot$.

Canalle and Opher (1988, 1989) examined the structure of the optical emission egion of the accretion column of magnetized white dwarfs, in particular, AM Herculis binaries. tudying the optical emission region, they took into account the variation with height of the agnetic field. A strong diverging magnetic field near the optical emitting region is redicted.

When the energy source region is situated above the base of a rapidly diverging agnetic field, an inverse energy population of electrons occurs producing electron cyclotron aser radiation at $\sim 75 - 80^o$ with respect to the magnetic field. We have the prediction at the rapidly diverging magnetic fields in YSO, OGS, the sun and near the optical emitting egion in AM Herculis binaries can produce strong electron cyclotron maser radiation at $75 - 80^o$ with respect to the magnetic field. The brightness temperatures can reach $\sim 10^{15}$ K.

Gouveia Dal Pino and Opher (1989d) studied the thermal synchrotron instability in upernova remnants. They found that an expanding shell with a radial magnetic field can fficiently form filaments in supernova remnants such as the Crab nebula. A compressed magnetic ield in these filaments is predicted.

Opher and Valio (1989) showed that gravitationally unbound condensations in olecular clouds can be due to thermal instability aiding gravity. These small clumps can ecome visible by compression-heating when collapsing or by masering if there is a nearby HII shocked region.

de Araujo and Opher (1988, 1989) studied the evolution of Population III objects om the recombination era as a function of redshift. For a $\Omega h^2 = 0.1$ universe, for example, e recombination redshift is 1481, where Ω is the ratio of the present to the critical ensity of the universe and h is the Hubble constant in units of 100 km/s-Mpc. Using eviously suggested isothermal density perturbation spectra, they evaluated the density and emperature of the evolving perturbation as a function of the redshift taking into account oton drag, photon cooling, photoionization by the background radiation, and the formation d destruction of the hydrogen molecule.

The formation of Population III objects come from nonlinear fluctuations of mass $10^6\, M_\odot$. A fluctuation of mass $\sim 10^6\, M_\odot$ produces a $T_B \gtrsim 3$ K on an angular scale $\Delta\phi \sim 600\ \Omega^{2/3}$ lliarcsecond (mas). We expect greater $T_B(\Delta\phi)^2$ for the Population III objects of smaller mass they collapse. We thus expect, in general, temperatures $T_B \gtrsim 10^6\ K(\Delta\phi)^{-2}\ \Omega^{4/3}$ on angular ales $\Delta\phi \lesssim 600\ \Omega^{2/3}$.

The above are new predictions which can be detected with present (or near future) BI sensitivities.

ACKNOWLEDGEMENTS

I would like to thank the Brazilian agency CNPq for partial support.

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