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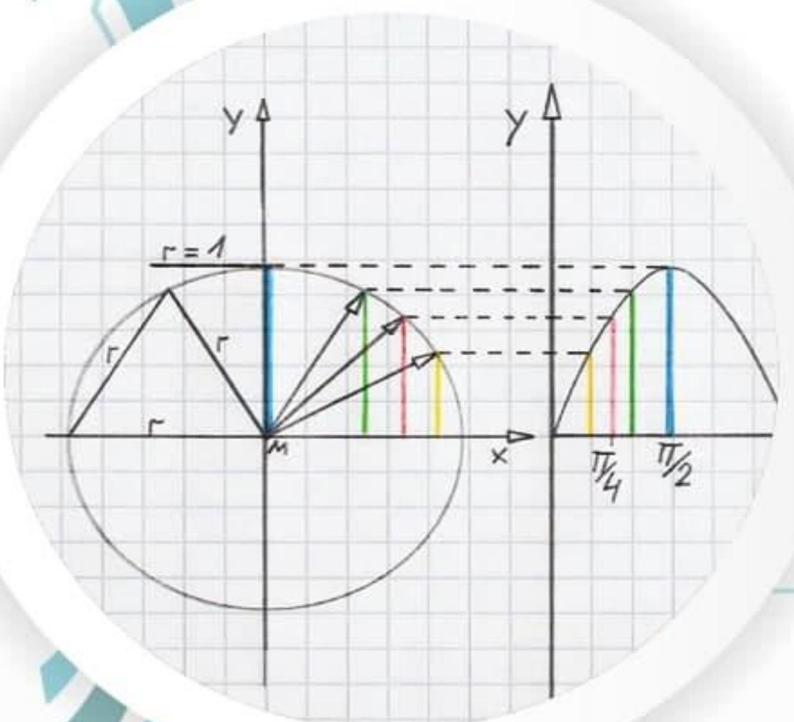

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BEHAVIOR OF THE MAGNITIC FIELD UNDER RANDOM GAZ CLOUD DEFORMATIONS

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Abstract. The clouds of the interstellar medium are considered, which from time to time undergo random deformations due to the influence of the gravitational fields of massive objects or due to uneven braking from the surrounding background. Qualitative behavior of the magnetic field inside of the cloud for a long time t is analyzed.

Keywords: interstellar medium, magnetic field, deformations of a cloud.

Magnetic fields play an important role in many astrophysical processes, such as the movement of charged particles, the evolution of gas clouds and their dynamic evolution [1; 2]. Here we select a model of linear deformations of a homogeneous ellipsoidal cloud. The behavior of the radius of the r_0 vector of a hydrodynamic particle is described by the relation,

$$A_n = A_n A_{n-1} \dots A_1 r_0$$

where r_0 - is the initial value of the radius of the vector, and random matrices A_n describe the cloud deformations in consecutive, also random at the moment t, following each other with an average time interval τ. The theory of multiplication of random matrices predicts that, with probability 1, [3]. The deformable ellipsoid is infinitely stretched into a "needle", i.e., the relations are valid for the semi-axes a_n, b_n , c_n

$$\lim_{n\to\infty} \frac{c_n}{b_n} = \lim_{n\to\infty} \frac{b_n}{a_n} = 0 .$$

Moreover, in addition to exceptional degenerate situations, the ratio of half-axes behaves, up to fluctuations, exponentially and there are limits

$$\lim_{n\to\infty}\frac{lna_n}{n}=\alpha,\quad \lim_{n\to\infty}\frac{lnb_n}{n}=\beta,\quad \lim_{n\to\infty}\frac{lnc_n}{b_n}=\gamma.$$

If the abc is a volume, which is physically natural, is maintained near one value. Then, obviously, $\alpha+\beta+\gamma=0$. It is possible to imagine that a magnetic field is frozen in the cloud, which is sufficiently weak and does not have a significant reverse effect on the deformation, but is subject to attenuation due to the final conductivity. Let us also assume that the specific conductivity of the surrounding background is significantly less, so that we can safely assume that the field in the environment is zero. The question arises about the qualitative behavior of the magnetic field inside the cloud at a large time t. To do this, it is sufficient to consider a simplified model of such a field, which is almost uniform in the last stages of deformation, when the ellipsoid turns into a thin elliptical disk. The internal field in this case will obviously be directed mainly parallel to the large axis, which can be taken as the x axis, while the z axis is perpendicular to the "pancake" plane. It is convenient to consider the field evolution between the moments of deformation as a one-dimensional process

$$\frac{\partial H_x}{\partial t}=\frac{c^2}{4\pi\sigma}\frac{\partial^2 H_x}{\partial x^2},$$

where σ- is the conductivity, c - is the speed of light. The solution of this equation, as is easily verified, goes to the asymptotic mode

$$\frac{\partial H_x}{\partial t}=-\mu H_x,\quad \mu=\frac{c^2}{4\pi\sigma c_0^2}$$

As for the deformations themselves, their smoothed effect would be described by the ratio $H_x\approx\frac{a_n}{a_0}H_0$ or, when switching from discrete time to continuous time for convenience

$$H(t)=k\exp\left(\frac{\alpha t}{\tau}\right),\quad (k=const.)\quad \text{or}\quad \frac{\partial H}{\partial t}=\frac{\alpha}{\tau}H.$$

When the combined effect of dissipation and deformation must take into account both terms in the transition for convenience from discrete time to continuous

$$\frac{\partial H}{\partial t} = \left(\frac{\alpha}{\tau} - \mu\right) H \approx \left(\frac{\alpha}{\tau} - \frac{c^2}{4\pi\sigma c_0^2}\right) H \,.$$

Since it is mandatory $\alpha > 0$, and c_0, on the contrary tends to zero, the value of $\frac{\partial H}{\partial t}$ becomes negative over time. This means that sooner or later the cloud's magnetic field will begin to decrease.

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