Rotation of a spiral galaxy without dark matter

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ABSTRACT

The star emits electromagnetic waves intensely, so its motion must be different from that of the planet. Centripetal acceleration during star rotation around the galactic center and the resulted radiative friction creates a valid alternative to the dark matter concept.

Charged particles in their individual or collective motion are known to generate plasma radiation. Radiation is the main cause of plasma energy loss. Accelerated motion of charged particles in an external electric or magnetic field underlies the mechanisms of radiation, based on the individual properties of charged plasma particles. The absorption of radiation inside the plasma leads to the effect of blocking radiation. This effect is manifested in the fact that the radiation is not coming from the entire volume of the plasma, but only from its outer layer.

The system emitting electromagnetic waves is not closed. Such a system is dissipative and the laws of conservation of energy and momentum are not applicable. When charged plasma particles move, an electromagnetic field arises, which slows down these particles. At the same time, radiation friction arises due to the emission of electromagnetic waves by moving particles. Considering radiation as a continuous process allows us to interpret it as the result of the action of some force, similar to the force of friction. To find a rigorous solution to such a problem, it is necessary to consider a dynamic system of charged particles and an electromagnetic field described by a complex system of nonlinear differential equations.

The quasi-neutral star plasma consists of electrons and positively charged ions of various types. In addition to its own plasma radiation, the accelerated motion of the star itself should produce some extra radiation. We assume that this radiation originates in all structural layers of the star, but eventually it is emitted into outer space mainly from its atmosphere. Thus, with the accelerated motion of the star, the force of radiation friction should arise. The rotation of a star around the galactic center, taking into account this friction force, is described by the equation

$$m\frac{v^2}{r} = G\frac{Mm}{r^2} - \frac{e^2 N}{6\pi\varepsilon_0 c^3 r}\frac{d(v^2)}{dt}, \tag{1}$$

where G is the gravitational constant, ε_0 is the vacuum permittivity, c is the speed of light in vacuum, e is the electron charge, v и m are the velocity and mass of the star, r is the distance from the center of the galaxy to the star, M is the mass of matter inside a conventional sphere with radius

r around which the rotation occurs, N is the effective number of individual charged particles involved in the formation of radiation in the star atmosphere. The solution of the Cauchy problem for equation (1) has the form

$$v^2 = \varphi + (v_0^2 - \varphi)\exp(-t/\tau), \tag{2}$$

$$\tau = \frac{e^2 N}{6\pi\varepsilon_0 c^3 m}, \quad \varphi = G\frac{M}{r},$$

where v_0 is the initial star velocity. For old star in the galaxy bulge, we can take $t \to \infty$. In this case, from (2) we obtain

$$v^2 = \varphi = \frac{4}{3}\pi G\rho r^2, \tag{3}$$

where ρ is the average density of matter in the galaxy. As it should be, a linear dependence follows from (3): $v \propto r$. For young star on the periphery or in the spiral arms of the galaxy, the situation is already different. For a young star $\exp(-t/\tau) \approx 1 - t/\tau$, therefore we find

$$v^2 = \varphi + (v_0^2 - \varphi)(1 - t/\tau). \tag{4}$$

If $t \ll \tau$ then $v \propto v_0 = \text{const}$. For such star, the rotation velocity is approximately constant and corresponds to the initial velocity at the time of their formation.

Thus, the rotation pattern of a star in the galaxy depends on the relationship between v_0 and φ as well as the τ value. It is known that stars were not born in the galaxy simultaneously and, therefore, they were included in the circular motion also not simultaneously, but as they appeared. The motion of the young stars ($t < \tau$) is apparently unsteady. Perhaps that's why the galaxy's rotation curve looks so unusual [1]. The present theory is consistent with Tully–Fisher relation, which determines the dependence of intrinsic luminosity of a spiral galaxy and its asymptotic rotation velocity [2]. The faster the galaxy spins, the stronger the radiative friction and the brighter it glows.

This note is for discussion. All of the above exclude the dark matter paradigm. The author shares the doubts that have been increasingly expressed recently regarding the existence of dark matter and the incompatibility of this concept with a number of observed phenomena.

REFERENCES

[1] W. J. G. de Blok, A. Bosma. High-resolution rotation curves of low surface brightness galaxies // Astronomy and Astrophysics. 385(3), 816–846 (2002).

[2] R.B. Tully, J. R. Fisher. A new method of determining distances to galaxies // Astronomy and Astrophysics. 54(3), 661–673 (1977).