

A MECHANISM FOR THE ORIGIN AND DEVELOPMENT OF SPIRAL ARMS IN A GALAXY

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It is generally believed that the constituents of a galaxy like ours are formed from an isolated gaseous assembly at successive stages, starting from a spheroidal subsystem down to the flattest subsystem.

We envision such a galaxy to have evolved to the stage where star formation is completed everywhere except in the flat gaseous subsystem. We postulate that this subsystem is permeated by a magnetic field of bipolar configuration, say a dipole, of which the axis is nearly perpendicular to the rotation axis of the galaxy. Circumstances leading to the formulation of this hypothesis and its consequences are discussed in the following papers: Pişmiş (1960, Huang and Pişmiş (1960, and Pişmiş (1961, 1963, 1965 and 1969). We now renew emphasis on the hypothesis by giving a sketch of it below.

It is expected that the gaseous subsystem will undergo contraction. The frozen-in magnetic lines of force will carry the gas along, except at the two polar regions where the plasma will leak out. The track of the material left behind the shrinking gaseous subsystem will delineate spiral arms through differential rotation. An application of this mechanism to M31 has rendered a spiral pattern with 1.5 turns in 3×10^9 years.

A number of observed properties in the Galaxy, seemingly unrelated to one another, find an explanation in a unified manner as a direct consequence of this mechanism. These properties are:

- a) The existence of a spiral pattern superposed on a "smooth" axisymmetric stellar system.
- b) The bi-symmetry of the spiral pattern.
- c) Magnetic field lines along the spiral arms. Recent observations of M51, presented by Fujimoto at this Symposium, support this statement.
- d) The reversal of the magnetic field where crossing the plane of the Galaxy.
- e) The warps observed in our and in other galaxies.

- f) The alternately up and down position of consecutive spiral arms (Henderson 1967).
- g) The gradual thickening of the neutral hydrogen layer towards the edges of the Galaxy.

The leakage of the gas from the magnetic poles may also occur as ejection; in this case, a fortiori, a spiral pattern ensues. We wish to emphasize that the magnetic field is used here only as a funneling agent and not to sustain spiral formations.

REFERENCES

- Henderson, A. P.: 1967, Ph.D. Thesis, University of Maryland.
- Huang, S. S., and Pişmiş, P.: 1960, Bol. Obs. Tonantzintla Tacubaya 2, 7.
- Pişmiş, P.: 1960, Bol. Obs. Tonantzintla Tacubaya 2, 3.
- Pişmiş, P.: 1961, Bol. Obs. Tonantzintla Tacubaya 3, 3.
- Pişmiş, P.: 1963, Bol. Obs. Tonantzintla Tacubaya 3, 127.
- Pişmiş, P.: 1968, Bol. Obs. Tonantzintla Tacubaya 4, 229.
- Pişmiş, P.: 1970, in IAU Symposium No. 38, ed. W. Becker and G. Contopoulos (Dordrecht: Reidel) pp. 452-454.