THE GALACTIC WAKE MODEL OF THE MAGELLANIC STREAM

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Tidal interaction models for the origin of the Magellanic Stream have been fairly successful in reproducing the radial velocities of the Stream (Lin and Lynden-Bell 1977, Davies and Wright 1977). However, no investigator has yet attained a self consistent treatment in which (1) the LMC and SMC are bound for at least $5x10^9$ yr, (2) the passing Magellanic Clouds warp the galactic plane, and (3) the Stream velocities are reproduced (Fujimoto and Sofue 1977). Also, Mathewson, Schwarz, and Murray (1977) argue that their 21 cm observations are evidence against the tidal model. To avoid these problems, they suggest that the Magellanic Clouds pass through a hot coronal gas and produce vortices in their wake which radiatively cool to form the HI clouds comprising the Stream.

Here we examine the possibility of forming HI clouds in this manner. The steady-state fluid equations for a non-expanding, viscous, heat-conducting-vortex were solved for a hot,fully-ionized gas in which vortices would appear in the wake (i.e. Reynolds number between 20 and 2500 and no magnetic field). These solutions show that the pressure decreases toward the center of the vortex and that the force generated by this pressure gradient balances the centrifugal force of the spinning gas. Because electron conduction is fairly efficient (Prandtl number is 0.05), the temperature gradient is much smaller than the density gradient so the cooling time increases toward the center of the vortex. Thus vortices can never be nucleation centers for HI clouds since they will remain hotter than the more rapidly cooling coronal gas. Furthermore, radiative cooling causes vortices to expand into the coronal gas and lose their integrity (for Pr $\leq$ 0.78). So, the suggestion of Mathewson et al. (1977) appears to be an inappropriate way of forming the Stream.

A more detailed discussion of this topic and a critical examination of other non-tidal theories will be presented elsewhere.

REFERENCES

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DISCUSSION

Giovanelli: Are any of your calculations particularly sensitive to the chemical composition of the gas?

Bregman: No. My conclusions are extremely insensitive to chemical composition.

Mirabel: Do you expect to find vortex motions on a scale of one degree? Our high-resolution observations of the Magellanic Stream made at Jodrell Bank do not show such motions for scale sizes of up to two degrees.

Bregman: The size of a vortex is comparable to the width of the wake behind the Magellanic Clouds. The angular extent in the sky depends on the distance to the Stream.

Mathewson: It is hazardous to extrapolate from the case of incompressible subsonic flow to that of diffuse material flowing supersonically past the Magellanic Clouds. The viscosity responsible for the formation of these eddies cannot be normal molecular viscosity but must be some form of turbulent viscosity associated with supersonic turbulent cells. A good illustration that this is a controversial point is Dr. S. Ikeuchi's (Hokkardo University) recently submitted paper (Astrophysics and Space Science) in which he supports the Turbulent Wake Theory of the Magellanic Stream and concludes that condensations can form in the wake of the Magellanic Clouds.

Basu: What is the time-scale for the survival of the vortex motion of which you have proposed?

Bregman: The vortex motion will last no longer than the cooling time of the gas. If vortex motion exists, it will linger for at least L/v, where L is the size of the Magellanic Cloud complex and v is their velocity through the hot coronal gas.