GALACTIC WINDS: THE ROLE OF COSMIC RAYS*

GARY P. ZANK
Max-Planck-Institut für Aeronomie
Postfach 20
D-3411 Katlenburg-Lindau
Federal Republic of Germany

The symbiotic nature of the relationship between galactic winds and cosmic rays (CR's) is attracting increasing interest since, on the one hand, galactic wind termination shocks have been invoked to explain the origin of the highest energy CR's (Jokipii and Morfill, 1985) while, on the other hand, it is thought that CR's may be the principal agent responsible for driving winds (Ipavich, 1975). A simple, spherically-symmetric galactic wind model which includes the dynamical effect of spatially diffusing CR's with an outward pressure gradient is presented. A hydrodynamic form of the cosmic ray transport equation is used, and the spatial diffusion coefficient κ is modelled as $\kappa \propto \rho^{\alpha}$ (ρ the gas density) for some parameter α. The choice of $\alpha < 0$ yields flow solutions which are subsonic at the source and supersonic at infinity. Such a choice of α corresponds to assuming that the level of Alfvén wave turbulence decreases with increasing distance from the galaxy. Near the galaxy κ is small and the cosmic rays are strongly coupled to the thermal gas, thus supplying additional momentum in the subsonic wind regime. Further from the galaxy, as κ increases, the cosmic rays decouple from the thermal gas and no longer contribute to the dynamics of the flow. Hence far from the galaxy, the Euler equations should be a suitable model. Furthermore, unlike classical wind models, a multiplicity of saddle points, and therefore flow solutions, exists. Finally, we show that $\alpha < 0$ is most likely to lead to stable, steady-state flows.

References

Ipavich, F.M. (1975) Astrophys. J. **196**, 107.
Jokipii, J.R. and Morfill, G. (1985) Astrophys. J. **290**, L1.

*Summary of a paper to be published in Astronomy & Astrophysics, 1989

R. Beck et al. (eds.), Galactic and Intergalactic Magnetic Fields, 182.