Acceleration of a Two Species Plasma from Moving Walls

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The Fermi acceleration model was first used as a means to describe how cosmic ray particles are accelerated to great speeds by interacting with moving magnetic fields [1]. Since then, many variations have been studied which simplify Fermi acceleration down to the interaction of bouncing balls and moving walls. One well known example is the Fermi-Ulam model which describes the acceleration of an ensemble of noninteracting particles bouncing between a moving wall and a stationary wall [2]. In our study, we present another variation of the model where a two species plasma interacts with a moving wall. If one species is allowed to be stationary and much more massive than the other, we can have energy conserving pitch angle scattering between the two species. Introducing this stochastic effect into the system will influence the frequency at which particles interact with the moving wall, and therefore also affect the total evolution of the plasma distribution function, $f(\mathbf{r},\mathbf{v},t)$. In particular, due to the relationship between the mean free path for Coulomb collisions and the speed of a particle, the rate at which a particle is accelerated by the moving wall may be heavily dependent on its initial speed and the density of the background species. This would imply that such a system could be tuned with these parameters to accelerate distributions of particles in a desired way. We analytically investigate this system from different perspectives to gain a more accurate description of the acceleration profile and to better understand the underlying physics. The result may uncover some interesting non-thermal effects which would provide insight on plasma acceleration mechanisms in general. This work is supported by NSF PHY-1805316.

References

[1] E. Fermi, Phys. Rev. **75**, 1169 (1949).

[2] S. Ulam, in *Proceedings of the Fourth Berkley Symposium on Mathematics, Statistics, and Probability* (California University Press, Berkley, 1961), Vol. 3, p. 315.