Scaling of astrophysical phenomena to high-energy-density laboratory experiments revisited

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In recent years, significant attention has been paid to the issues of scalability of natural astrophysical phenomena to their small-scale laboratory imitations and a broad set of similarities has been established for hydrodynamic and magnetohydrodynamic systems (e.g., [1,2]). It was emphasized [3] that the development of a scaled experiment is by no means limited to establishing relevant dimensionless parameters but has to include several other important steps, like preliminary 1D numerical runs, determining the appropriate initial and boundary conditions, identifying possible constraints on the duration of the experiment, etc. Generally, including radiation and ionization effects leads to strongly constrained similarities [4, 5], although meaningful scaled experiments still remain possible. Collisionless systems of relevance to astrophysics have also been assessed in terms of scaling laws and some broad scaling relations have been established [6-8]. After a brief review of these earlier results, the author will discuss three issues: 1) Identifying and utilizing the situations where a collapse of a set of scaling constraints to a smaller set of scaling constraints is possible; 2) Developing a concept of scaled experiments allowing the establishing of possible effects of weak dissipative processes on the intermittency and other properties of a large-scale motion; 3) Identifying scalings relevant to reconnection phenomena in high-density, collisional plasmas.

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