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**Laboratory Study of Fundamental Plasma Processes in Astrophysics: Progress and Opportunities**[1]

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Advances in astrophysics (including heliophysics) are led by new observations from recent satellites and ground-based observatories, revealing detailed plasma dynamics ranging from Earth's magnetospheric activity, solar wind turbulence, solar/stellar flares, gamma ray bursts, efficient energy release from hot accretion disks, to cosmic rays at highest energies. Many of these phenomena are surprising and demand better understanding. Motivated by these astrophysical observations, a large number of laboratory experiments, equipped by significant progress in controls, diagnostics, and numerical simulations, have been performed to study underlying fundamental plasma physics. This talk is intended to highlight recent achievements on the following three selected topics. (1) On the topic of magnetic reconnection,[2] which is considered to be responsible for rapid release of magnetic energy in astrophysics, the classical Sweet-Parker model has been tested successfully in collisional laboratory plasmas while two-fluid effects, including detailed electron-scale dynamics, are observed to be essential for fast reconnection. (2) On the topic of flow stability,[3] which is considered to govern accretion processes and turbulent mixing in highly dynamic astrophysical plasmas, a major candidate hydrodynamic instability of Keplerian flows has been effectively eliminated by laboratory experiments while the magnetic field effects on the flow stabilities are explored and quantified. (3) On the topic of shock waves, which are considered to be a generic mechanism for the observed particle heating and acceleration, laboratory experiments have successfully produced the shocks dominated by radiative processes, and experiments on generation of collisionless shocks are underway. Dynamic behaviors of the shock front consisting of fine structures are measured and quantitatively compared with the state-of-the-art numerical predictions. The bright future of this growing field will be reflected in discussions of several near term major scientific opportunities, highlighted from the report of a community-based Workshop on Opportunities in Plasma Astrophysics (WOPA).[4]

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[2]M. Yamada, R. Kulsrud, and H. Ji, "Magnetic Reconnection," Rev. Mod. Phys. **82** (2010) 603.

[3]H. Ji, "Current Status and Future Prospects for Laboratory Study of Angular Momentum Transport Relevant to Astrophysical Disks," Advances in Plasma Astrophysics, Proc. IAU Symp. #274, Sicily Island, Italy (2010) p.18.

[4]http://www.pppl.gov/conferences/2010/WOPA