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Collisionless shocks driven by supersonic plasma flows with self-generated magnetic fields[1]

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Collisionless shocks are ubiquitous in the universe, a consequence of supersonic plasma flows sweeping through interstellar and intergalactic media. It has been speculated that these shocks are the cause of many astrophysical phenomena, but details of shock structure and behavior have remained controversial because of a lack of ways to study them experimentally. Generation of astrophysically relevant, collisionless shocks in the laboratory has therefore been an important experimental goal during the last several decades for scientists wanting to explain numerous fascinating astrophysical phenomena and developing an incisive platform for studying a broad range of fundamental physics. Laboratory experiments reported here, with astrophysically relevant plasma parameters, demonstrate the formation of a quasi-perpendicular magnetized collisionless shock. In the upstream it is fringed by a filamentated turbulent region, a rudiment for a secondary Weibel-driven shock. This turbulent structure is found responsible for electron acceleration to energies exceeding the average energy by two orders of magnitude. These experiments mimic the scenario of collisionless shocks in nonrelativistic astrophysical contexts, and provide insight into shock physics in relativistic contexts. This work was performed in collaboration with V. T. Tikhonchuk, Q. Moreno, H. Sio, E. D'Humières, X. Ribeyre, Ph. Korneev, S. Atzeni, R. Betti, A. Birkel, E.M. Campbell, R. K. Follett, J. A. Frenje, S. X. Hu, M. Koenig, Y. Sakawa, T. C. Sangster, F. H. Seguin, H. Takabe, S. Zhang, and R. D.Petrasso. [Phys. Rev. Lett. (2019)].

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