Teller Award Lecture: Travels Through High-Energy-Density Physics

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I have had the great good fortune to work with many talented people in a career that has wound its way through most areas of high-energy-density physics. Our joint efforts are what led to this award. Today I will share with you some of the research and the stories from my journey, and especially some things that may have implications going forward for this area of science and for inertial confinement fusion (ICF).

Mike Campbell recruited me into this field from magnetic fusion, and I spent my first decade in it focused on laser plasma interactions. The Novette and Nova lasers proved to be wonderful tools for the study of Stimulated Raman Scattering (SRS), much to the distress of ICF managers. We did manage to make some progress on understanding SRS, and on several related topics. A bit later, after I left ICF, it was fun to produce ion plasma waves and study a few other details.

In the early 1990s Bruce Remington talked me into joining him in pursuing what we now call High Energy Density Laboratory Astrophysics, which turned out to lead me first into hydrodynamics. This led to work in creating structures of interest and in studying the primary instabilities of compressible hydrodynamics under various circumstances. I will emphasize some connections among laboratory astrophysics experiments, ICF experiments, and simulations.

Our astrophysical colleagues called for laboratory experiments in radiation hydrodynamics and in collisionless shocks, and this led me into both these areas. The first challenge was to create and study radiative shocks in laboratory experiments. This took a lot of learning and a good bit of work. It was technologically hard in the 1990's, but got easier in succeeding years. As matters developed, we ended up training a long sequence of graduate students and post docs on this topic, we created a code that has proven useful, and we did some worthwhile work on uncertainty quantification. More recently, a number of us have turned our attention to the challenge of producing photoionization fronts in the laboratory, which likewise is not proving easy.

In parallel with radiation hydrodynamics, it was very interesting to learn some things about collisionless shocks. This led to a design paper published in 2000, but I did not prove able to get a facility funded at the time to pursue them. With time, though, several groups have pursued this topic and begun to have success. More broadly, the area of magnetized flows has emerged as a major area of research activity.

It is my hope that this presentation will leave you with a sense of how rich the field of high-energy-density physics is, and with a few good stories from its past, and with a few ideas for what might come next.

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