Abstract Submitted
for the DPP17 Meeting of
The American Physical Society

Exact collisional moments for plasma fluid theories DAVID PFEFFERLE, EERO HIRVIJOKI, PPPL, MANASVI LINGAM, Harvard John A. Paulson School of Engineering and Applied Sciences, Harvard University — The velocity-space moments of the often troublesome nonlinear Landau collision operator are expressed exactly in terms of multi-index Hermite-polynomial moments of the distribution functions. The collisional moments are shown to be generated by derivatives of two well-known functions, namely the Rosenbluth-MacDonald-Judd-Trubnikov potentials for a Gaussian distribution. The resulting formula has a nonlinear dependency on the relative mean flow of the colliding species normalised to the root-mean-square of the corresponding thermal velocities, and a bilinear dependency on densities and higher-order velocity moments of the distribution functions, with no restriction on temperature, flow or mass ratio of the species. The result can be applied to both the classic transport theory of plasmas, that relies on the Chapman-Enskog method, as well as to deriving collisional fluid equations that follow Grad's moment approach. As an illustrative example, we provide the collisional ten-moment equations with exact conservation laws for momentum- and energy-transfer rate.

David Pfefferle
PPPL

Date submitted: 14 Jul 2017 Electronic form version 1.4