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From Lawson to Burning Plasmas: a Multi-Fluid Approach[1]
LUCA GUAZZOTTO, Auburn University, RICCARDO BETTI, University of Rochester — The Lawson criterion [1], easily compared to experimental parameters, gives the value for the triple product of plasma density, temperature and energy confinement time needed for the plasma to ignite. Lawson's inaccurate assumptions of 0D geometry and single-fluid plasma model were improved in recent work, where 1D geometry and multi-fluid (ions, electrons and alphas) physics were included in the model, accounting for physical equilibration times and different energy confinement times between species [2]. A much more meaningful analysis than Lawson's for current and future experiment would be expressed in terms of burning plasma state (Q=5, where Q is the ratio between fusion power and heating power). Minimum parameters for reaching Q=5 are calculated based on experimental profiles for density and temperatures and can immediately be compared with experimental performance by defining a no-alpha pressure. This is done in terms of the pressure that the plasma needs to reach for breakeven once the alpha heating has been subtracted from the energy balance. These calculations can be applied to current experiments and future burning-plasma devices. [1] J. D. Lawson, Proc. Phys. Soc. London Sect. B 70, 6 (1957) [2] L. Guazzotto and R. Betti, to appear in Phys. Plasmas

[1]DE-FG02-93ER54215

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