Two-Dimensional Simulation of Pellet Ablation with Atomic Processes

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Abstract. A new time-dependent two-dimensional (2D) hydrodynamic code applicable to solid, fluid, and gas states, "PELL2D" has been developed in order to investigate the dynamics of pellet ablation in magnetized plasmas. One of the novelties of the code is that it treats the phase change at pellet surface without imposing artificial boundary conditions there, as done in all previous ablation models. The code includes atomic processes, mainly molecular dissociation and thermal ionization. It was found that ionization causes the formation of a stationary shock front in the supersonic region of the ablation flow, followed by a "second" sonic surface farther out. Anisotropic heating caused by the directionality of the magnetic field leads to a nonuniform pressure distribution over the pellet surface. This can lead to a deformation of "soft" hydrogen pellets, causing them to be become highly elongated in the cross-field direction. It was found that this 2D effect can shorten the pellet life time by a factor of two from that assuming 1D spherically symmetric heating.