Effects of Equation of State on fluid simulations for laser-produced plasmas

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Abstracts: *We have developed the simulation code for laser-ablation plasmas. Our code uses both HLL-HLLC Riemann solver and the upwind difference method to treat two-temperature model of ion and electron in the shock-capturing scheme. As the equation of states model for the laser-ablation, we applied BADGER model to our simulations and compared the simulation results using several equation of state models.*

In the numerical calculation of fluid dynamics for laser-ablation plasmas, it is necessary to capture the shock front and discontinuity surface and to avoid numerical oscillations. In order to overcome these numerical problems, we have used Godunov-type Riemann solver which is in the conservative form. However, for the laser-ablation we have to consider the two-temperature model for respective ion and electron because the relaxation time between ion and electron often becomes longer than the duration of laser pulses. In order to calculate numerically the two-temperature fluid model with shock capturing scheme, we have developed the new scheme. This new scheme uses both HLL-HLLC Riemann solver which is one of the conservation schemes and the upwind difference method, and we could simulate laser-ablation plasmas robust for ideal gases.

For the realistic simulation of laser-ablation, the equation of state (EOS) model is also important. We applied BADGER model to our simulations. BADGER model has three electron ionization models; 1) Thomas-Fermi model, 2) the screened hydrogenic model with *l*-splitting and 3) the individual electron accounting model. The latter two models take into account quantum effects. Also, BADGER model does not use bonding correction as used in QEOS. Figure 1(a) and (b) show SESAME and BADGER plot for electron equation of state, respectively. BADGER table has smooth and different values in the low temperature region compared to SESAME table. We simulated the laser-ablation with several equations of state models among BADGER model, QEOS and SEAME to compare the effects of equation of state on the hydrodynamics for the laser-ablation. Our simulations using of BADGER model show the realistic and robust results.

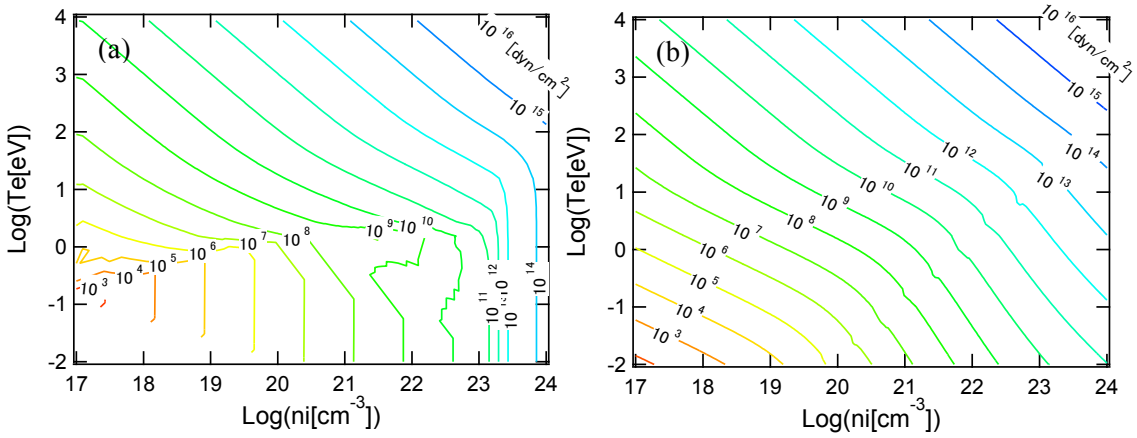

Fig.1 Electron equation of state of (a)QEOS model and (b) BADGER model