IMPLOSION UNIFORMITY IMPROVEMENT OF FUEL TARGET IN HEAVY ION FUSION

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In inertial fusion, the fusion fuel compression is essentially important to reduce an input driver energy, and the implosion uniformity is one of critical issues to compress the fusion fuel stably. Therefore, the Rayleigh-Taylor instability (RTI) stabilization [1] or mitigation [2, 3] is attractive to minimize the fusion fuel mix.

Previous studies have shown that RTI is mitigated by an oscillating acceleraration perturbation [2]. Let us consider an unstable system, which has one mode of $a = a_0 e^{ikx+\gamma t}$. Here a_0 is the amplitude, k is the wave number and γ the growth rate of the instability. An example initial perturbation is shown in Fig. 1(a). At $t = 0$ the perturbation is imposed. The initial perturbation grows with γ. After Δt, if another perturbation, which has an inverse phase, is actively imposed (see Fig. 1(b)), the overall amplitude is the superposition of all the perturbations, and so the actual perturbation amplitude is well mitigated as shown in Fig. 1(c). This is an ideal example for the dynamic instability mitigation.

We examined whether the dynamic instability mitigation mechanism is robust. The result showed that we found the robustness against the change in the phase, the amplitude and the wavelength of the perturbation [3]. Figures 2 show example simulations for RTI. In this example, two stratified fluids are superposed under an acceleration of $g = g_0 + \delta g$. The density jump ratio between the two fluids is 10/3. In this specific case the oscillating frequency Ω is the RTI growth rate γ, the amplitude of δg is $0.1\mathrm{g}_0$, and the results shown in Figs. 2 are those at $t = 5/\gamma$. In Fig. 2(a) δg is constant and drives the RTI as usual, in Fig. 2(b) the phase of δg is oscillates with the frequency of Ω as stated above for the dynamic instability mitigation, and in Fig. 2(c) the wavelength depends on time. In Fig. 2(c), the wave number $k(t) = k_0 + \Delta k e^{i\Omega t}$ and $\Delta k / k_0 = 0.3$. We conclude that dynamic instability mitigation mechanism is robust.

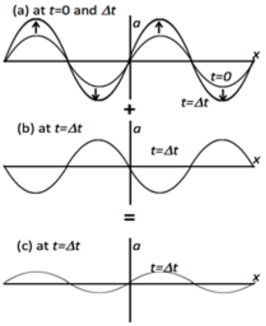
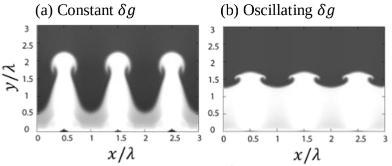


FIG. 1 An ideal example concept of the dynamic mitigation.


(a) Constant δg

(b) Oscillating δg

(c) Oscillating δg ($k = k(t)$)

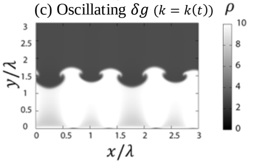


FIG. 2 Example simulation results for the Rayleigh-Taylor instability mitigation.

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[3] S. Kawata and T. Karino, Phys. Plasmas, **22** (2015) 042106.