A Numerical Simulation for the Cooling Process of the Solar Flare Loop

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Extended abstract: We have simulated numerically the hydrodynamic cooling process after the maximum phase of a solar flare with improvements on the chromospheric radiative loss and the resolution of the transition region, together with the introduction of the mechanism of chromospheric heating by coronal soft X-rays. The main results are as follows:

1. At the early stage of the gradual phase, thermal conduction maintains chromospheric evaporation, but with the cooling of the atmosphere, chromosphere evaporation decreases gradually.
2. In most of the gradual phase, the velocity is smaller than $40\,\mathrm{km\,s^{-1}}$ in the corona and $4\,\mathrm{km\,s^{-1}}$ in the chromosphere.
3. From the middle stage of the gradual phase, the coronal atmosphere appears to have a quasi-periodic oscillation. The period is about two minutes, and the amplitude of velocity is within $\pm 20\,\mathrm{km\,s^{-1}}$.
4. The transition region continues to move downward at first and then changes very slowly for quite a long time. The upward motion of the transition region takes place only at the latest stage, when the atmosphere cools below the quiet-Sun case.
5. In contrast to the changes of temperature, the density of the corona does not seem to vary until the violent descent of coronal material takes place at the end of the gradual phase.
6. The coronal part cools mainly by thermal conduction, while the chromospheric part cools by radiative loss. With our initial model, it takes about 25 minutes for cooling from the maximum phase to nearly the quiet-Sun case.
7. The soft X-ray heating of the chromosphere seems to be of negligible importance in our calculations, but if the coronal density is greater than $10^{11}\,\mathrm{cm^{-3}}$ at the maximum phase of the flare, the soft X-ray heating may play some role in the gradual phase.
8. At the latest stage of the gradual phase, the atmosphere remains dense and at low temperature. As a further consequence, it would evolve into a post-flare loop.

It is also found that the calculated results are closely related to accuracy in resolving the transition region. Poor resolution of the transition region gives false results.

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Gan, W. Q. and Fang, C., 1990, *Astrophys. J.*, **358**, 328.