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Understanding the coronal heating in various stellar environments: Effect of metallicity

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It is necessary to study the coronal heating across diverse stellar conditions to extend our knowledge from solar to stellar atmospheres. Among the stellar parameters, metallicity is one of the key factors to control coronal properties because it affects the energy loss through radiation in the atmosphere. We investigate the heating of stellar coronal loops, which are the fundamental building blocks of the atmosphere, by one-dimensional magnetohydrodynamic simulations.

Our simulations have demonstrated that the metallicity exerts a notable impact on the physical and radiative properties of stellar coronae. It is revealed that the coronal temperature and density are higher for lower metallicity because radiative cooling is suppressed. Accordingly, our estimates for the X-ray and EUV luminosities give the larger values for lower-metallicity coronae. Notably, the X-ray luminosity shows a steep dependence on metallicity (Figure 1, [1]). These results on the coronal radiation would have a large impact on the evolution on protoplanetary disks and planetary atmospheres through gas evaporation.

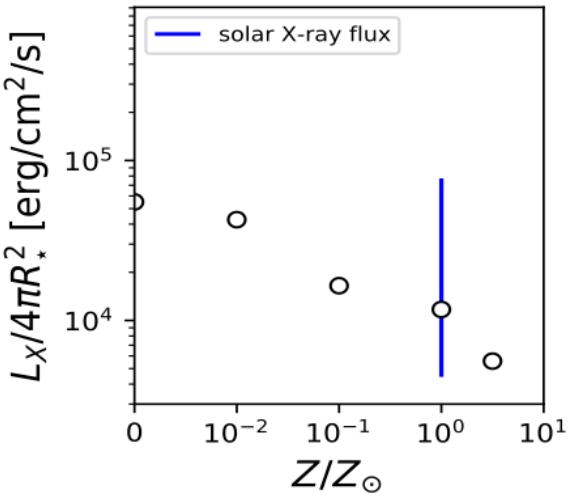

Figure 1. Estimated X-ray flux with metallicity. The blue bar shows the solar X-ray flux.

To unite the modeling for solar and stellar coronae, we derived the scaling relations for a coronal loop from the energy balance among heating, radiative cooling and thermal conduction, as an extension of the RTV scaling laws for the Sun [2]. This generalization allows us to characterize the coronal properties under a wide variety of stellar environments once the optically thin radiative loss function for the plasma gas is obtained. This series of studies extends our understanding of stellar coronal heating, which can be a ground work for future studies on stellar atmospheres.

References

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