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Deep Autoencoder Applied for Feature Extraction of Temporal Variations in Quasar Optical Flux

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Abstract

Quasars have long been known as intrinsically variable sources, but the physical mechanism underlying the temporal optical/UV variability is still under discussion from the first identification of the optical variability of quasars in the middle of the twentieth century. In this paper, we proposed a nonparametric method for modeling and forecasting the optical temporal variation of quasars utilizing an autoencoder neural network, to gain insight of the physical mechanism on the temporal flux variation of quasars. The autoenoder is trained and validated by ~10 yrs long ~15,000 quasar light curves obtained by the Catalina Real-Time Transient Survey, where the quasars are selected to be the flux contamination from the hist galaxy is negligible in the temporal variation. Its performance in forecasting the temporal flux variation is superior to that of the Ornstein–Uhlenbeck process. In addition, a novel relation, the magnitude of the temporal variability asymmetry decreases as luminosity and/or black hole mass increases, is suggested with the help of autoencoded features. We conclude that the characteristics of the variability asymmetry are in agreement with those resulted in from simulation with the self-organized disk instability model, which predicts that the magnitude of the variability asymmetry decrease as the ratio of the diffusion mass to inflow mass in the accretion disk increases.