論文 / 著書情報
Article / Book Information

題目(和文)	深層自己符号化器によるクエーサー可視光光度変動の特徴量抽出
Title(English)	Deep Autoencoder Applied for Feature Extraction of Temporal Variations in Quasar Optical Flux
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	物理学系・物理学コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （ 理学 ）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Quasar, a type of active galactic nuclei denoting bright cores at the center of galaxies, is recognized as that it contains a supermassive central black hole with a mass of ~10^6–10^9 solar masses. The central black hole is thought to be surrounded by a gaseous accretion disk, and the gravitational energy in it is released in the form of photon radiation as gas falls toward the black hole. Although quasars have long been known as intrinsically variable sources since the identification of the optical variability of quasars in the middle of the twentieth century, the physical mechanism underlying the temporal optical/UV variability remains unclear.

In this thesis, we proposed a nonparametric method for modeling and forecasting the optical temporal variation of quasars utilizing an "autoencoder neural network", which is a type of unsupervised machine learning algorithms, to gain insight of the physical mechanism on the temporal variation of the accretion disc. The model is trained by ~10 yrs long ~15,000 quasar light curves obtained by the Catalina Real-Time Transient Survey, which has been operational since 2007 November. The performance of this model in forecasting the temporal flux variation is superior to that of the damped random work model (or Ornstein–Uhlenbeck process; OU process), which has been the most broadly accepted model to describe the optical temporal variability in quasars. In addition, autoencoded features can be interpreted as the most representative characteristics of the temporal variability of quasars. With the help of the features, a novel relation that the magnitude of the temporal variability asymmetry decreases as luminosity and black hole mass increases is suggested. We found 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. Additionally, an ensemble autocorrelation function of the flux temporal variations exhibits higher correlation coefficients in the short timescale variability (~–60 d) than those expected from the OU process, and then decreases rapidly. This behavior can be interpreted by a significant contribution of the reverberation by the accretion disk and/or the broad line region. Both of the reverberation and the diffusion mass rate should be responsible for the variability asymmetry. Our results indicate that the optical/UV temporal variability in quasars should not be a purely stochastic process, but that a deterministic component certainly exists in it.

Running/upcoming massive synoptic sky survey such as ZTF, TESS, and LSST will provide us with ample and high-quality datasets of the optical temporal variability of quasars. Further modification of our analysis method would be enabled in the near future, and will allow us to connect the deterministic component in the temporal flux variability of an individual quasar, not of an ensemble, to underlying physical mechanisms.