# ２０２１年度

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# 修士論文発表会

# 論文要旨集

２０２１年８月１７日（火）、２０日（金）

タイトル：OPTICAL VARIABILITY OF BLAZARS IN THE TOMO-E GOZEN NORTHERN SKY TRANSIENT SURVEY

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アブストラクト：

In this study, we used Tomo-e Gozen Northern Sky Transient Survey data to study the BL Lac class of blazars and FSRQ class of blazars recorded in the 4FGL catalog. We set observation date, magnitude, limiting magnitude, zero magnitude, and other restrictions to select data that can be trusted, and we used SDSS standard stars as photometric references which have negligible variabilities. The photometric error was compared with magautoerr given by Source-Extractor. The former was factor larger, and we infer zero point determination error and flat-field error are still significant in our photometry.

Then, we obtained structure functions $sf(\tau)$ to study the characteristics of the optical variability of blazers. The influence of its luminosity and redshift on optical variability is also analyzed.

The amplitude of structure functions of FSRQs is higher than previously expected, and the amplitude of structure functions of FSRQs is significant higher then the amplitude of structure functions of BL Lacs. This phenomenon becomes more obvious in a short time interval. Both two classes of blazars FSRQs and BL Lacs with luminosity in the range of $10^{46} erg\ cm^{-2}\ s^{-1} \sim 10^{47} erg\ cm^{-2}\ s^{-1}$ has largest $sf(\tau)$, and $sf(\tau)$ decreases to fainter or brighter luminosity ranges. The optical variability of high redshift BL Lacs is higher than other BL Lacs, but the optical variability of FSRQ does not directly depend on luminosity or redshift. This may imply that the activities of BL Lacs in the early universe are more intense than the recent BL Lacs. And for FSRQs in the same cosmological epoch, FSRQs with low luminosity or higher redshift have lower optical variability.

# Abstract

# Stellar models of Betelgeuse ($\alpha$-Ori) constrained using observed surface conditions

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We study the viability of stellar models as Betelgeuse's progenitor using the HR diagram and surface abundances of carbon, nitrogen, and oxygen as observational constraints. Previous studies on Betelgeuse stellar modelling have not systematically investigated the surface abundances for a grid of models, and this study is performed on the basis that we believe surface abundances can be impacted by, and thus be used as observational constraint for various parameters such as initial mass, rotation velocity, and overshoot scheme. We investigate stellar models with varying initial mass as they evolve from ZAMS to beyond the main sequence, and we examine the red supergiant (RSG) properties in detail. For each mass, we also vary the initial rotation up to $v/v_{\rm K} = 0.4$, and test two overshoot parameters of $L_A$ ($f_{ov} = 0.01$) and $M_A$ ($f_{ov} = 0.03$). We find that the acceptable initial mass range differs depending on the initial parameters. Using $f_{ov} = 0.01$, the acceptable initial mass range is only 15 to 25 $M_\odot$, but if applied with $f_{ov} = 0.03$, the acceptable initial mass range expands to 12 to 26 $M_\odot$. For rotating models, we find that $v/v_{\rm K} = 0.4$ models are unable to fit to Betelgeuse's surface abundances as an RSG, raising conflicts with initial rotation velocity found in literature. For Betelgeuse's current stage of evolution, we report that for all models $> 20$ $M_\odot$, as well as some 17 and 20 $M_\odot$ models, their time of fit corresponds to the midst of core helium burning. However, we also find that in $\leq 15$ $M_\odot$ models, the time of fit can persist into the core carbon burning stages. Among 17 and 20 $M_\odot$ models, there are cases of both possibilities. Finally, in this study we do not consider the observed surface velocity of Betelgeuse as it cannot be explained by a single star evolution model. Instead, we discuss the implications of our results in the context of merger scenarios which have been suggested as a theory to attain satisfactory surface velocity.