the observed [O III] line profiles of type 2 AGNs can be well reproduced. In addition, we perform Monte Carlo simulations based on the different sets of model parameters. By comparing the model results with the observed [O III] kinematics of ~39,000 SDSS type 2 AGNs (Woo et al. 2016), we find that the observed [O III] velocity-velocity dispersion distribution is well reproduced by the biconical outflow model, enabling us to constrain the intrinsic physical parameters of outflows.

항성

[구 ST-01] KIC 6220497: A New Algol-type Eclipsing Binary with δ Sct Pulsations

Jae Woo Lee
Korea Astronomy and Space Science Institute, Daejeon 34055

We present the physical properties of KIC 6220497 exhibiting multiperiodic pulsations from the Kepler photometry. The light curve synthesis represents that the eclipsing system is a semi-detached Algol with a mass ratio of q=0.243, an orbital inclination of i=77.3 deg, and a temperature difference of ΔT=3,372 K, in which the detached primary component fills its Roche lobe by ~87% and is about 1.6 times larger than the lobe-filling secondary. To detect reliable pulsation frequencies, we analyzed separately the Kepler light curve at the interval of an orbital period. Multiple frequency analyses of the eclipse-subtracted light residuals reveal 32 frequencies in the range of 0.75-20.22 d^{-1} with semi-amplitudes between 0.27 and 4.55 mmag. Among these, four frequencies (f_1, f_2, f_5, f_7) may be attributed to pulsation modes, while the other frequencies can be harmonic and combination terms. The pulsation constants of 0.16-0.33 d and the period ratios of P_{pul}/P_{orb} = 0.042-0.089 indicate that the primary component is a δ Sct pulsating star in p modes and, thus, KIC 6220497 is an oscillating eclipsing Algol (oEA) star. The dominant pulsation period of about 0.1174 d is considerably longer than the values given by the empirical relations between the pulsational and orbital periods. The surface gravity of log g_1 = 3.78 is significantly smaller than those of the other oEA stars with similar orbital periods. The pulsation period and the surface gravity of the pulsating primary demonstrate that KIC 6220497 would be the more evolved EB, compared with normal oEA stars.

[구 ST-02] The first photometric analysis of the close binary system NSVS 1461538

Hyoun-Woo Kim, Chun-Hwey Kim
Department of Astronomy and Space Science, Chungbuk National University, Cheongju, 28644, Korea

The follow-up BVRI photometric observations of NSVS 1461538, which was discovered as an Algol/β Lyr eclipsing variable by Hoffman, Harrison & McNamara (2009), were performed for three years from 2011 to 2013 by using the 61-cm telescope and CCD cameras of Sobaeksan Optical Astronomy Observatory (SOAO). New light curves have deep depths both of the primary and secondary eclipses, rounded shapes outside eclipses and a strong O'Connell effect, indicating that NSVS 1461538 is a typical W UMa close binary system rather than an Algol/β Lyr type binary star. A period study with all the timings shows that the orbital period may vary in a sinusoidal way with a period of about 5.6 yr and a small semi-amplitude of about 0.008 d. The cyclical period variation was interpreted as a light-time effect due to a tertiary body with a minimum mass of 0.66M⊙. The first photometric solution with the Wilson-Devinney binary model shows that the system is a W-subtype contact binary with the mass ratio ($q=m_c/m_h$) of 3.46, orbit inclination of 85.6 deg and fill-out factor of 30%. From the existing empirical relationship between parameters, the absolute dimension was estimated. The masses and radii of the component stars are 0.28M⊙ and 0.71R⊙ for the less massive but hotter primary star, respectively, and 0.96M⊙ and 1.21R⊙, for the more massive secondary, respectively. Possible evolution of the system is discussed in the mass-radius and the mass-luminosity planes.

[구 ST-03] The First Photometric Study of the Neglected Contact Binary GX Aurigae

Jang-Ho Park[1,2], Jae Woo Lee[1], and Chun-Hwey Kim[2]
[1]*Korea Astronomy and Space Science Institute,*
[2]*Chungbuk National University*

New CCD photometric observations of GX Aur have been made between 2004 and 2015. Our light curves are the first ever compiled and display the variable O'Connell effect. The light variations are satisfactorily modeled by including time-varying cool-spots on the component stars. Our light curve synthesis indicates that the eclipsing pair is an A-type contact binary with parameters of i = 81.1 deg, ΔT = 36 K, q = 0.950 and f = 46%. Including

our 25 timing measurements, a total of 83 times of minimum light spanning about 66 yr were used for a period study. It was found that the orbital period of GX Aur has varied due to two periodic oscillations superposed on an upward-opening parabolic variation. The long-term period increase rate is deduced as $+9.636\times10^{-10}$ d yr^{-1}, which can be produced as a mass transfer from the secondary star to the primary at a rate of 3.136×10^{-6} $M_\odot$ yr^{-1}, among the largest rates for contact systems. The periods and semi-amplitudes of the two periodic variations are about P_3 = 8.7 yr and P_4 = 21.2 yr, and K_3 = 0.011 d and K_4 = 0.017 d, respectively. The most reasonable explanation for both cycles is a pair of light-travel-time effects driven by the possible existence of an unseen third and fourth components with projected masses of M_3 = 0.91 $M_\odot$ and M_4 = 1.09 $M_\odot$ in eccentric orbits of e_3 = 0.13 and e_4 = 0.73. Because no third light was detected in the light curve synthesis, each circumbinary object could be a compact star or a binary itself.

[구 ST-04] Apsidal motions of 90 eccentric binary systems in the Small Magellanic Cloud

Kyeongsoo Hong[1], Jae Woo Lee[1,2], Seung-Lee Kim[1,2], Jae-Rim Koo[1], and Chung-Uk Lee[1,2]
[1]Korea Astronomy and Space Science Institute,
[2]University of Science and Technology

We examined thousands of light curves of stars brighter than 18.0 mag in I band and less than mean magnitude error of 0.1 mag in V band from the OGLE-III eclipsing binary catalogue, and found 90 new binary systems exhibiting apsidal motion. In this study, the samples of apsidal motion stars in the SMC were increased by 250 percent than previously known. In order to determine the period of the apsidal motion for the binaries, we analysed in detail both light curves and eclipse timings using the MACHO and OGLE photometric database obtained for about 20 yrs. For the eclipse timing diagrams of the systems, new times of minimum light were derived from the full light curve combined at intervals of one yr from the survey data. The binaries presented in this paper have apsidal motion periods in the range of 12-918 yrs. An additional short-term oscillation was detected in five systems (OGLE-SMC-ECL-1634, 1947, 3035, 4946, and 5382), which most likely arise from the existence of a third body orbiting each eclipsing binary. All of the selected systems can be used for the statistical study of the interior structure of the stars in the SMC through their apsidal motions due to the homogeneous data and consistent analysis methods.

[구 ST-05] Wolf-Rayet star evolution with clumpy envelope structure.

Hye-Eun Jang, Sung-Chul Yoon
Seoul National University

It is well known that theoretical models of Wolf-Rayet stars are not consistent with observational data in terms of temperature and stellar radius. Recent study in analytical and numerical simulations show the importance of density inhomogeneity in stellar envelope. Using 1-dimensional numerical simulations, we study how such clumpiness arisen over convective surface of Wolf-Rayet stars affect their evolutionary path. Starting from pure helium star models, we constructed 21 different initial conditions by varying stellar mass, metallicity, and the clumpiness of the sub-surface convection zone. We run the simulations until the oxygen-burning is reached and find that the influence of the clumpiness is sensitive to the initial metallicity. Our models with high metallicity including the effect of the density inhomogeneity can roughly explain the observed properties of Wolf-Rayet stars such as stellar radius and temperature. By contrast, despite a considerable amount of density inhomogeneity is given, low metallicity models could not fully explain observations. To understand the inconsistency in low metallicity models, detailed study with improved model is required, taking account of the error range of the observations.

[구 ST-06] Infrared-Visible Photometric Analyses of Core-collapse Supernovae and Supernova Dust Formation

Mina Pak[1,2], Dae-Sik Moon[3], Sang Chul KIM[1,2], Pegah Salbi[3], Avishay Gal-Yam[4], Ho-Gyu Lee[1], and CCCP Members
[1]Korea Astronomy and Space Science Institute (KASI), Republic of Korea,
[2]Korea University of Science and Technology (UST), Republic of Korea,
[3]Department of Astronomy and Astrophysics, University of Toronto, Canada,
[4]Department of Particle Physics and Astrophysics, Faculty of Physics, The Weizmann Institute of Science, Israel

We present multiband photometric analyses of