IGRINS Newsletter

Dear IGRINS Community

In January of 2014, four years ago, IGRINS arrived at UT Austin from KASI and the final alignments were made. Since commissioning ended in Summer 2014, IGRINS has been scheduled on more than 650 nights at McDonald Observatory and the Discovery Channel Telescope (DCT). Improvements to the mechanical systems and software have simplified instrument support and increased the flexibility of IGRINS scheduling.

The biggest change in 2018 will be IGRINS' visit to Gemini South for 50 science nights in April-July 2018. Fifteen of the Gemini nights are dedicated to a Large Program targeting the Ophiuchus star forming region. The other 35 nights are for community programs, to be observed by the IGRINS Team as a queue, and are supported by the NSF through grant AST-1702267.

There are now three postdocs at UT Austin dedicated to IGRINS science and instrument support. Kimberly Sokal (UT), Heeyoung Oh (KASI) and Ricardo Lopez-Valdivia (UT) are focused on young stellar objects and the interstellar medium. They will also be the primary IGRINS observers and contacts for the next year - so get to know them!

June 10-15, 2018, the SPIE Astronomical Telescopes and Instrumentation conference will be held in Austin and we look forward to using this opportunity to collaborate and meet with the IGRINS community.

In September 2018 we will accept UT/KASI requests for IGRINS at the DCT. We anticipate this third visit lasting from October 2018 through April 2019. Please let us know how we can help you publish your IGRINS science!

With best wishes,

Dan Jaffe and the IGRINS Team

Contents

1 Updates

1.1 Current IGRINS Status and Performance

IGRINS is currently at the DCT, but will soon return to Austin for the first time since Summer 2016. In that time, it has visited the DCT, McDonald Observatory, and the DCT again. Improvements to software have improved observing, logging, and data reduction. Adjustments to facilities have reduced the amount of equipment that moves with IGRINS and stabilized the instrument during power failures.

1.2 Scientific Data from the McDonald Commissioning Runs

Any member of the astronomical community may examine the IGRINS commissioning data to help form their future proposals. Science verification data from the commissioning runs are processed using the current pipeline and available online http://kgmt.kasi.re.kr/igrins/pipeline/. Please be sure to read the Sample Data Policy, also available on the same website. More information on these data can be found in previous newsletters: HERE.

1.3 IGRINS @ DCT

Between the first (Fall/Winter 2016) and second (Fall/Winter 2017) visit to the DCT the instrument mount was redesigned. This has adjusted the focus of IGRINS to allow for instrument guiding or facility guiding. Additionally, the facility lifting fixture for the instrument was remade to increase safety and usability, and all IGRINS components are now on the facility UPS. In the 11 months that IGRINS has been at the DCT it has been scheduled on ~100 full nights and ~80 half nights. We anticipate that IGRINS will return to the DCT in September 2018 for a third visit. More information on these plans will be reported in the next newsletter.

1.4 IGRINS @ Gemini South

For the first time, IGRINS will be at Gemini South during Spring/Summer 2018. Information about the IGRINS visit to Gemini is located on the dedicated webpage HERE. Requests for IGRINS at Gemini in 2018A outnumbered all the other instrument requests and 20 programs were awarded time in Bands 1–3. Time was awarded by the US, Canadian, Korean, Chilean, and Argentinian TACs.

In preparation for the visit, IGRINS will get a new input optics assembly to translate the telescope beam to the required f/10 of the instrument and the coldhead will be replaced. Then IGRINS will be shipped to Gemini at the end of February 2018. In March 2018 IGRINS will be unpacked and installed at Gemini, with commissioning scheduled for the first week of April 2018. There are 50 IGRINS nights scheduled in the three months that it is available at Gemini South. IGRINS will return to Austin in July or August 2018 and will be prepared to return to the DCT in September.

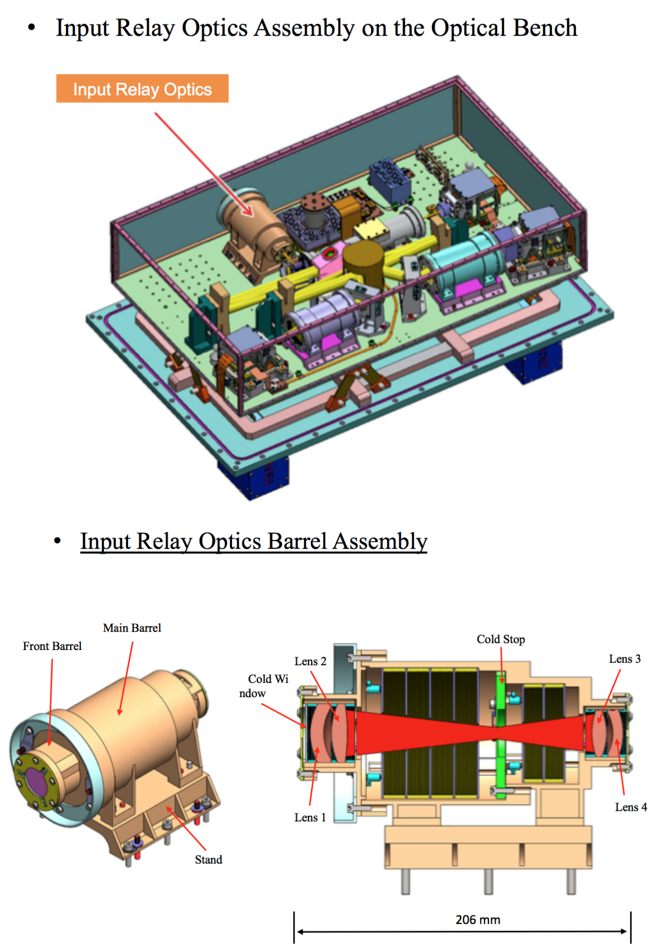

Figure 1 *Top: The IGRINS optical layout with the input optics identified. Bottom: A closeup and cut-away of the input optics.*

1.5 IGRINS PLP

In previous newsletters a few different versions of the data reduction pipeline were referenced. There is now a single version (2.2) that should be used for all data reduction https://github.com/igrins/plp/releases. With this release, Anaconda Python and conda environments can be used for easier install https://github.com/igrins/plp/wiki/How-to-run-pipeline.

2 Recent Publications

Here we highlight recent IGRINS publications. A full list of publications can be found HERE. If you have plans to publish IGRINS results soon, then be sure to contact the IGRINS Team to make sure that your work follows team guidelines. General publication guidelines can be found at the end of the newsletter.

2.1 Characterizing TW Hydra

Sokal et al. 2018 - At 60 pc, TW Hydra (TW Hya) is the closest example of a star with a gas-rich protoplanetary disk, though TW Hya may be relatively old (3-15 Myr). As such, TW Hya is especially appealing to test our understanding of the interplay between stellar and disk evolution. We present a high-resolution near-infrared spectrum of TW Hya obtained with the Immersion GRating INfrared Spectrometer (IGRINS) to re-evaluate the stellar parameters of TW Hya. We compare these data to synthetic spectra of magnetic stars produced by MoogStokes, and use sensitive spectral line profiles to probe the effective temperature, surface gravity, and magnetic field. A model with T_{eff}= 3800 K, log g=4.2, and B=3.0 kG best fits the near-infrared spectrum of TW Hya. These results correspond to a spectral type of M0.5 and an age of 8 Myr, which is well past the median life of gaseous disks.

2.2 The Young Substellar Companion ROXs 12 B: Near-infrared Spectrum, System Architecture, and Spin-Orbit Misalignment

Bowler et al. 2017 - ROXs 12 (2MASS J16262803-2526477) is a young star hosting a directly imaged

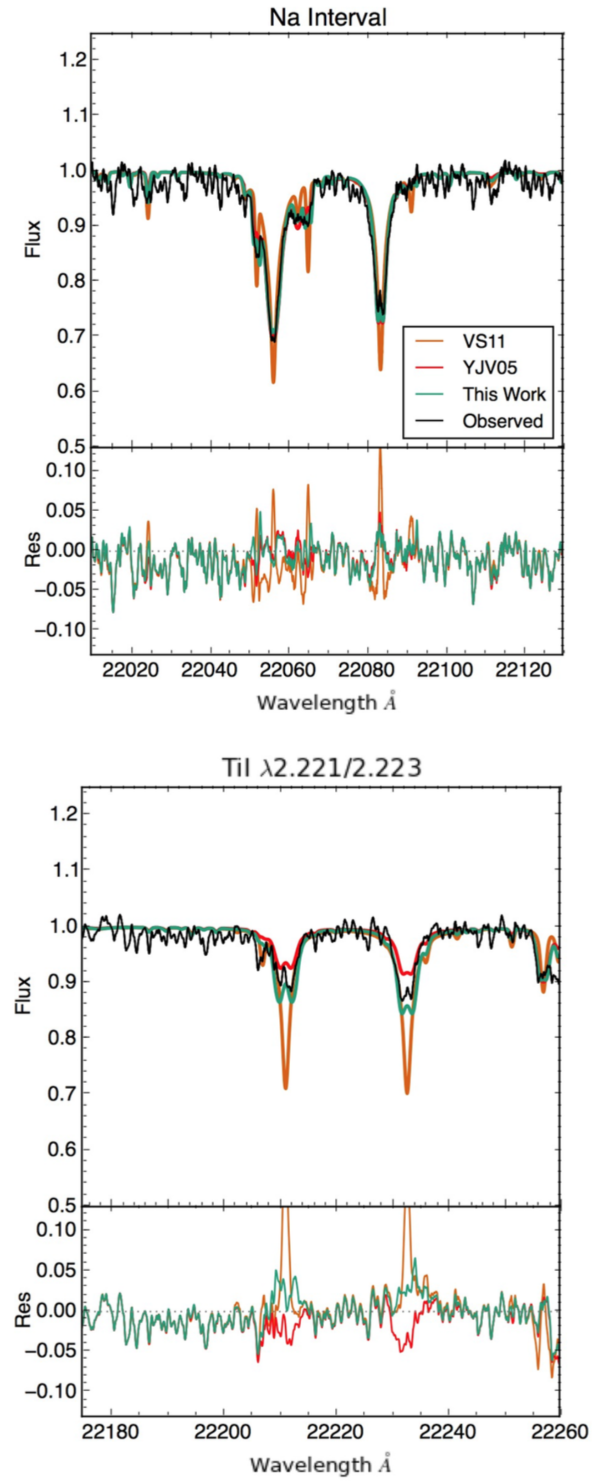

Figure 2 *From Figure 6 of Sokal et al. 2018. The observed IGRINS spectrum (black line) of TW Hya in comparison to MoogStokes synthetic spectra matching the estimated parameters of this paper and the literature. The difference between the observed and synthetic spectra is shown in the bottom panels, with an increased y-axis scale.*

companion near the deuterium-burning limit. We present a suite of spectroscopic, imaging, and time-series observations to characterize the physical and environmental properties of this system. Moderate-resolution near-infrared spectroscopy of ROXs 12 B from Gemini-North/NIFS and Keck/OSIRIS reveals signatures of low surface gravity including weak alkali absorption lines and a triangular H-band pseudocontinuum shape. No signs of Pa emission are evident. As a population, however, we find that about half (46% ± 14%) of young (≤15 Myr) companions with masses ≤20 M Jup possess actively accreting subdisks detected via line emission, which represents a lower limit on the prevalence of circumplanetary disks in general, as some are expected to be in a quiescent phase of accretion. The bolometric luminosity of the companion and age of the host star (6-2+4 Myr) imply a mass of 17.5 ± 1.5 M Jup for ROXs 12 B based on hot-start evolutionary models. We identify a wide (5100 au) tertiary companion to this system, 2MASS J16262774-2527247, that is heavily accreting and exhibits stochastic variability in its K2 light curve. By combining v sin I * measurements with rotation periods from K2, we constrain the line-of-sight inclinations of ROXs 12 A and 2MASS J16262774-2527247 and find that they are misaligned by 60-11+7°. In addition, the orbital axis of ROXs 12 B is likely misaligned from the spin axis of its host star, ROXs 12 A, suggesting that ROXs 12 B formed akin to fragmenting binary stars or in an equatorial disk that was torqued by the wide stellar tertiary.

2.3 Magnetic Inflation and Stellar Mass. I. Revised Parameters for the Component Stars of the Kepler Low-mass Eclipsing Binary T-Cyg1-12664

Han et al. 2017 - Several low-mass eclipsing binary stars show larger than expected radii for their measured mass, metallicity, and age. One proposed mechanism for this radius inflation involves inhibited internal convection and starspots caused by strong magnetic fields. One particular eclipsing binary, T-Cyg1-12664, has proven confounding to this scenario. Cakirli et al. measured a radius for the secondary component that is twice as large as model predictions for stars with the same mass and age, but a primary mass that is consistent with predictions. Iglesias-Marzoa et al. independently measured the radii and masses of the component stars and found that the radius of the secondary is not in fact inflated with respect to models, but that the primary is, which is consistent with the inhibited convection scenario. However, in their mass determinations, Iglesias-Marzoa et al. lacked independent radial velocity measurements for the secondary component due to the star's faintness at optical wavelengths. The secondary component is especially interesting, as its purported mass is near the transition from partially convective to a fully convective interior. In this article, we independently determined the masses and radii of the component stars of T-Cyg1-12664 using archival Kepler data and radial velocity measurements of both component stars obtained with IGRINS on the Discovery Channel Telescope and NIRSPEC and HIRES on the Keck Telescopes. We show that neither of the component stars is inflated with respect to models. Our results are broadly consistent with modern stellar evolutionary models for main-sequence M dwarf stars and do not require inhibited convection by magnetic fields to account for the stellar radii.

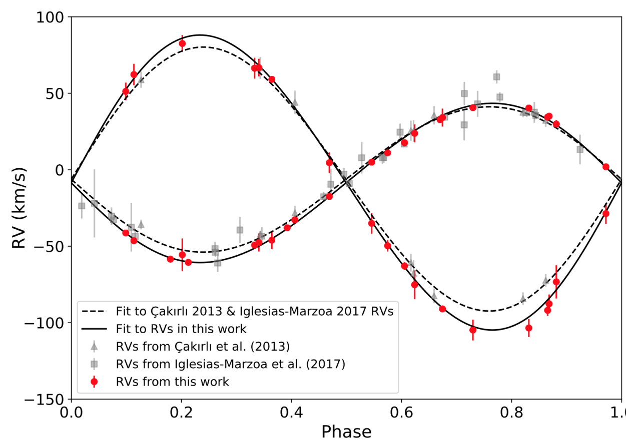

Figure 3 *Figure 9 from Han et al. 2017. Best-fit to the radial velocity data. The solid line is best-fit with IGRINS, NIRSPEC, and HIRES data and the dashed line is the best-fit for literature data. The calculated radial velocity semi-amplitudes are K1= 52.3±1.2 km/s for the primary and K2= 97.3±1.3 km/s for the secondary.*

2.4 Inner Warm Disk of ESO Hα 279a Revealed by NA I and CO Overtone Emission Lines

Lyo et al. 2017 - We present an analysis of near-infrared, high-resolution spectroscopy toward the flat-spectrum young stellar object (YSO) ESO Hα 279a (~1.5Msun) in the Serpens star-forming region at a distance of 429 pc. Using the Immersion GRating INfrared Spectrometer (IGRINS; R~45,000), we detect emission lines originating from the accretion channel flow, jet, and inner disk. Specifically, we identify hydrogen Brackett series recombination, [Fe II], [Fe III], [Fe IV], Ca I, Na I, H2, H2O, and CO overtone emission lines. By modeling five bands of CO overtone emission lines and the symmetric double-peaked line profile for Na I emission lines, we find that ESO Hα 279a has an actively accreting Keplerian disk. From our Keplerian disk model, we find that Na I emission lines originate between 0.04 and 1.00 AU, while the CO overtone emission lines are from the outer part of the disk, in the range between 0.22 and 3.00 au. The model reveals that the neutral atomic Na gas is a good tracer of the innermost region of the actively accreting disk. We derive a mass accretion rate of 2-10 x 10^{-7} Msun/yr from the measured Brγ emission luminosity of 1.78($\pm$0.31) x 10^{31} erg/s.

2.5 EPIC 220204960: A Quadruple Star System Containing Two Strongly Interacting Eclipsing Binaries

Rappaport et al. 2017 - We present a strongly interacting quadruple system associated with the K2 target EPIC 220204960. The K2 target itself is a Kp = 12.7-mag star at $T_{eff} \approx 6100$ K, which we designate as 'B-N' (blue northerly image). The host of the quadruple system, however, is a Kp = 17-mag star with a composite M-star spectrum, which we designate as 'R-S' (red southerly image). With a 3.2-arcsec separation and similar radial velocities and photometric distances, 'B-N' is likely physically associated with 'R-S', making this a quintuple system, but that is incidental to our main claim of a strongly interacting quadruple system in 'R-S'. The two binaries in 'R-S' have orbital periods of 13.27 and 14.41 d, respectively, and each has an inclination angle of $\geq 89°$. From our analysis of radial-velocity (RV) measurements, and of the photometric light curve, we conclude that all four stars are very similar with masses close to 0.4 Msun. Both of the binaries exhibit significant eclipse-timing variations where those of the primary and secondary eclipses 'diverge' by 0.05 d over the course of the 80-d observations. Via a systematic set of numerical simulations of quadruple systems consisting of two interacting binaries, we conclude that the outer orbital period is very likely to be between 300 and 500 d. If sufficient time is devoted to RV studies of this faint target, the outer orbit should be measurable within a year.

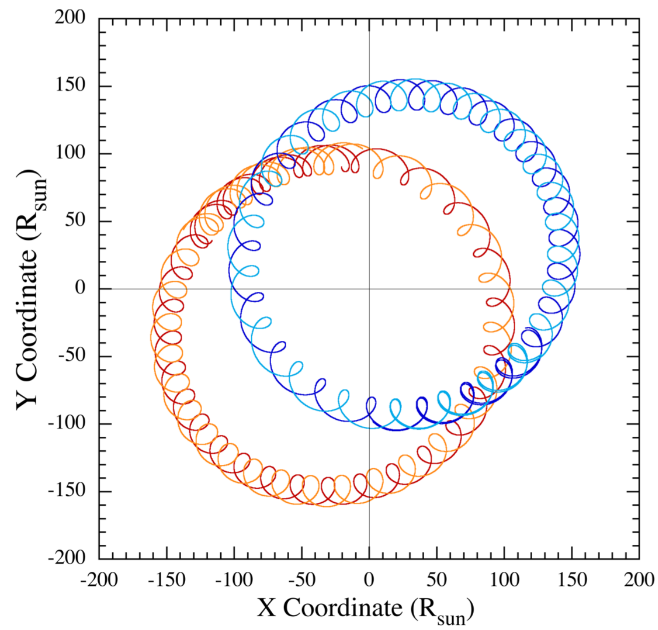

Figure 4 *Figure 14 from Rappaport et al. 2017. Orbital motion of the EPIC 220204960 quadruple system for an assumed illustrative outer orbital period of 500 days and eccentricity of 0.3. The orbital tracks of all four stars are shown in different colors.*

3 Publication Policy

Observing PIs are expected to analyze and publish their data promptly. The current proprietary period is 24 months from the date the data are taken. Decisions about authors and author orders of publications are the responsibility of the proposal PI. The IGRINS team member(s) on the observing proposal(s) should be included as paper authors. Wherever possible, PI's should seek reasons to give first authorships to junior team members, in particular to students and postdocs. All authors should have intellectual ownership of the material and have contributed to the work. The IGRINS team is committed to ethics in publication and does not condone courtesy authorships. For this reason, please involve junior team members throughout the scientific process.

Acknowledgements: The standard acknowledgement for IGRINS is: "This work used the Immersion Grating Infrared Spectrometer (IGRINS) that was developed under a collaboration between the University of Texas at Austin and the Korea Astronomy and Space Science Institute (KASI) with the financial support of the US National Science Foundation under grants AST-1229522 and AST-1702267, of the University of Texas at Austin, and of the Korean GMT Project of KASI." The facility that IGRINS is used at should also be acknowledged. IGRINS' spectral resolution is R∼45,000. Any paper using IGRINS science or engineering data must reference the designated IGRINS instrument citations(s):

Park, C. et al., Design and early performance of IGRINS (Immersion Grating Infrared Spectrometer), Proc. SPIE 9147 (2014).

Jae-Joon Lee, Kevin Gullikson, & Kyle Kaplan. (2017, August 18). igrins/plp 2.2.0. Zenodo. http://doi.org/10.5281/zenodo.845059

Mace, G. et al., 300 nights of science with IGRINS at McDonald Observatory, Proc. SPIE 9980 (2016).

Refereeing: The IGRINS team has an internal refereeing process for observing and instrumentation papers. We strongly recommend that all papers to be submitted to a refereed journal, and using IGRINS data or technical information, go through the IGRINS internal refereeing process. Papers for non-refereed conference proceedings may also make use of this service. Revisions in response to these comments can be made at the discretion of the authors. First authors should inform Jae-Joon Lee (leejjoon@kasi.re.kr), Kimberly Sokal (ksokal@utexas.edu), and/or Lisa Prato (lprato@lowell.edu) of submitted papers. At the time of acceptance, please provide us with the title, journal, volume, and full author list.