IGRINS Newsletter -- 2016 Trimester 1

Dear IGRINS community:

IGRINS has now had 251 nights at McDonald Observatory since commissioning in Spring 2014 and is scheduled for 32 more nights in the remainder of 2016T1. IGRINS will be available for all of 2016T2 (April-July) on the 2.7 meter at McDonald Observatory. The IGRINS 2015 workshop at Seoul National University in November connected many of the American and Korean IGRINS users and encouraged additional collaboration with invited talks from Drs. Matteo Brogi, Greg Herczeg, John Rayner and Nils Ryde. In this edition of the newsletter we summarize the November science workshop, report the current instrument status, remind observers of their obligations when requesting IGRINS time, and summarize recent science results from IGRINS.

The next proposal deadline is February 1st, 2016, at 8am for 2016T2. We would like to take this opportunity to remind IGRINS users of the proposal guidelines. If you plan to submit a proposal, please contact one of the instrument team members. An ongoing complaint from the TAC is that IGRINS proposals fall short in their feasibility review and clearly stating date requirements on the coversheets. **Proposals should be sent to your IGRINS collaborator by January 25th so they can be reviewed for feasibility ahead of the proposal deadline (February 1st).** Proposals that meet these early deadlines do remarkably better with the TAC.

We would like to form IGRINS working groups. These groups will be assigned their own mailing list and will be a way for people with similar science goals to communicate. Please fill out the form at this link to be added to a working group:
http://goo.gl/forms/cbrIH31veP

Science publications are a major goal for the IGRINS instrument team. There are a number of submitted IGRINS papers, and many more in preparation. We would like to advertise IGRINS successes on department websites and through press releases. So, please don't hesitate to share your science!

With best wishes,
Dan Jaffe and the IGRINS Team

1. Current IGRINS Status and Performance

IGRINS is in good condition. In November 2015 we were able to leave IGRINS mounted to the telescope while observers used the Tull Coude Spectrograph, which is a safer mode for storing IGRINS between runs. Major power outages at McDonald have tested the robustness of IGRINS, and no design issues have been revealed. We continue to work on converting IGRINS into a facility instrument with some trusted observers now observing solo and much of the daily maintenance handled by McDonald staff. This includes documentation and procedural notes, as well as procuring spare components.

The Pipeline Package is continuing to be developed by Dr. Jae-Joon Lee (https://github.com/igrins/plp/wiki). Alpha testing of version 2.1 (August 2015 release) of the pipeline is in process and available to observers. This new version includes an improvement contributed by Kevin Gullikson that employs telluric absorption in bright sources to refine the wavelength solution. Thanks to Kyle Kaplan, the next version will also save a 2D variance maps in "*.var2d.fits". The IGRINS wiki pages are continually updated and we ask that the IGRINS community consult them for observing guidelines, instrument manuals, links to other software, and troubleshooting (https://wikis.utexas.edu/display/IGRINS/Manuals). A new version of the observing software with improved guiding is in the final stages of testing and should be deployed in the near future.

2. Scientific Data from the 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 on Dr. Jae-Joon Lee's website (http://leejjoon.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:
https://wikis.utexas.edu/display/IGRINS/IGRINS+Newsletters

3. Considerations for IGRINS Users

The IGRINS slit moves when the instrument is warmed to room temperature, resulting in shifts as large as 1 arcsecond between observing runs. This shift in the slit position creates a shift in the echellogram that is 50% of the slit motion. Observers should check the positioning of the AB boxes when starting an observing run and expect shifts in the echellogram between observing runs. This effect is small and still being characterized.

The faintest guide star used to-date was K=13 mag with 30s slit-view images. If your target is fainter than K=10mag then you should have off-slit guide stars prepared for your target. It is possible to guide-by-hand if no guide star is available, but this can be tedious and will reduce the amount of total flux collected. Updates to the guiding software may change these limits in the near future.

If you plan to use the IGRINS pipeline, we suggest that you take a sky frame with a minimum of 300sec exposure to improve the wavelength solution of your processed data. If you have science frames with exposures of this length, then they will work as sky frames too. Observers will also want to get UNe calibration frames nightly since progress is being made to utilize them for improving the pipeline wavelength solution. The guideline to take calibration frames can be found here
https://wikis.utexas.edu/display/IGRINS/Taking+Calibrations.

IGRINS needs one qualified 107" observer **and** one qualified IGRINS observer. This is to ensure safe operation and efficient use of the awarded time. We will continue to supply the IGRINS observer at team expense, but very experienced observers may be able to observe alone. We need you to supply the 107" observer. You will need to support this observer with your own funds. Please see the McDonald website for requirements.
http://www.as.utexas.edu/mcdonald/policy/vacant_time.html#TRAINING

4. IGRINS Mini-Queue in Janaury 2016

The last IGRINS mini-queue deadline was January 11th, 2016 and the mini-queue will be executed January 29, 30, 31 and February 1st. There were 22 requests for this time. The next mini-queue has not yet been scheduled, but will not be until after July 2016.

5. IGRINS Science Meeting in Korea

The second IGRINS Science Workshop (the first since commissioning) took place November 9-13, 2015 at Seoul National University. The 3-day working meeting focused on collaboration and IGRINS data analysis techniques. There was then a two-day Science Symposium including review science talks, technical talks, and contributed talks based on IGRINS results and future projects. The presentations have been posted online: http://kgmtscience.kasi.re.kr/igrins2015/

Science Highlights:

A few of the initial science results from IGRINS are discussed below. If you would like to share your progress in the next newsletter, please let us know and we will be sure to contact you when we begin to put it together. If you have plans to publish IGRINS results soon, then be sure to contact the IGRINS PIs to make sure that your work follows team guidelines. Publication guidelines can be found at the end of the newsletter.

ADS Listed Science Papers:

Jeong-Eun Lee, Sunkyung Park, Joel D. Green, William D. Cochran, Wonseok Kang, Sang-Gak Lee, Hyun-Il Sung, ***High Resolution Optical and NIR Spectra of HBC 722***, ApJ, 2015, 807, 84

Kevin Gullikson, Adam Kraus, Sarah Dodson-Robinson, Daniel Jaffe, Jeong-Eun Lee, Gregory N. Mace , Phillip MacQueen, Sunkyung Park, and Andrew Riddle, ***Direct Spectroscopic Detection: An Efficient Method to Detect and Characterize Binary Systems***, AJ, 2016, 151, 3

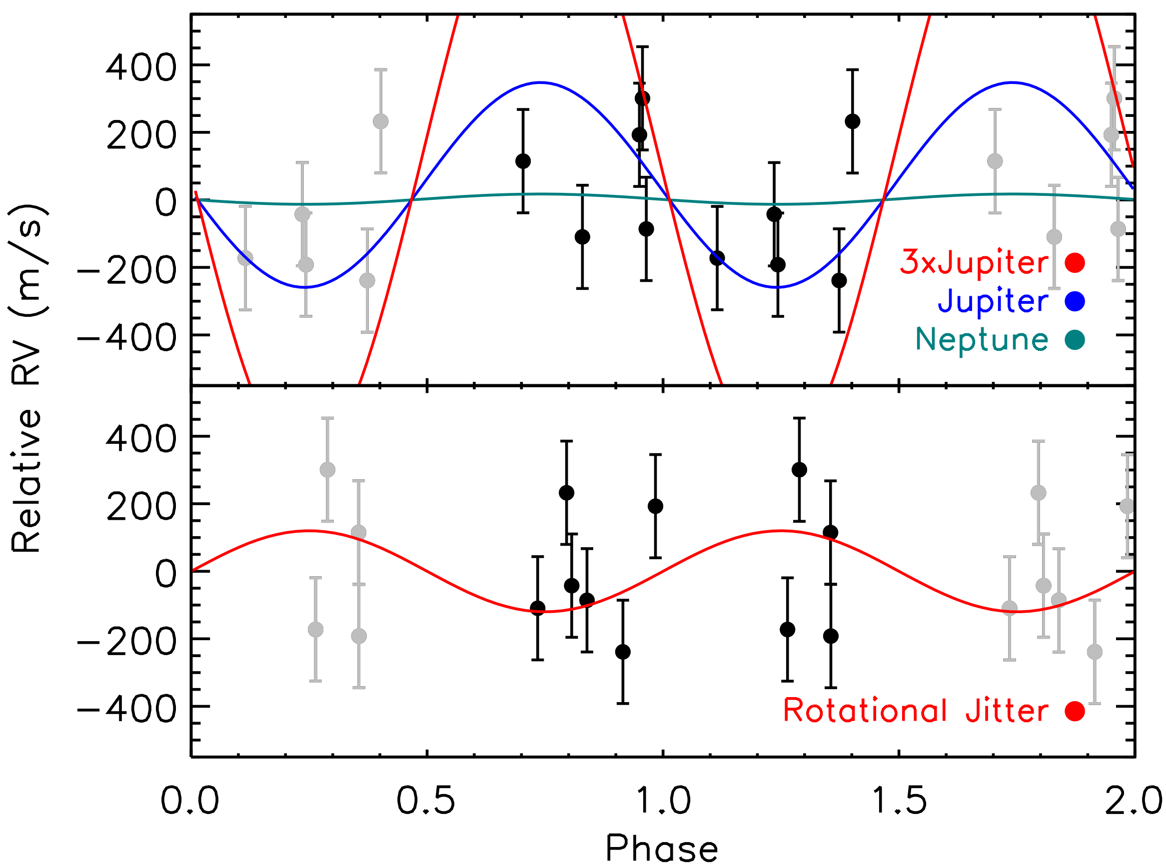
Andrew Mann, Eric Gaidos, Gregory Mace, Marshall Johnson, Brendan Bowler, Daryll LaCourse, Thomas Jacobs, Andrew Vanderburg, Adam Kraus, Kyle Kaplan, and Daniel Jaffe, ***Zodiacal Exoplanets In Time (ZEIT) I: A Neptune-sized planet orbiting an M4.5 dwarf in the Hyades Star Cluster***, 2016, ArXiv e-prints., ApJ accepted

Melike Afşar, Christopher Sneden, Anna Frebel, Hwihyun Kim, Gregory N. Mace, Kyle F. Kaplan, Hye-In Lee, Hee-Young Oh, Jae Sok Oh, Soojong Pak, Chan Park, Michael D. Pavel, In-Soo Yuk, Daniel T. Jaffe, ***The Chemical Compositions of Very Metal-Poor Stars HD 122563 and HD 140283; A View From the Infrared***, 2016, ArXiv e-prints., ApJ accepted

Heeyoung Oh, Tae-Soo Pyo, In-Soo Yuk, Byeong-Gon Park, Chan Park, Moo-Young Chun, Soojong Pak, Kang-Min Kim, Jae Sok Oh, Ueejeong Jeong, Young Sam Yu, Jae-Joon Lee, Hwihyun Kim, Narae Hwang, Kyle Kaplan, Michael Pavel, Gregory Mace, Hye-In Lee, Huynh Anh Nguyen Le, Sungho Lee, Daniel T. Jaffe, ***IGRINS Near-IR High-Resolution Spectroscopy of Multiple Jets around LkHα 234***, 2016, ArXiv e-prints., ApJ accepted

Zodiacal Exoplanets In Time (ZEIT) I:
A Neptune-sized planet orbiting an M4.5 dwarf in the Hyades Star Cluster
Andrew Mann, Eric Gaidos, Gregory Mace, Marshall Johnson, Brendan Bowler, Daryll LaCourse, Thomas Jacobs, Andrew Vanderburg, Adam Kraus, Kyle Kaplan, and Daniel Jaffe

Planets and their host stars evolve with time, and the first few hundred Myr are thought to be the most formative. Final assembly of rocky terrestrial planets is predicted to occur in 10-100~Myr, but regular accretion of residual planetesimals would continue to influence physical and chemical conditions on these planets. More rapid rotation and magnetic activity drive elevated X-ray and ultraviolet emission and coronal mass ejections from the host star, potentially eroding the primordial atmospheres of close-in planets on this time scale. While thousands of exoplanets have been discovered, most by the NASA Kepler transiting planet survey mission, the vast majority of these orbit old (>Gyr) stars. The repurposed Kepler mission (K2), however, has observed 10-800 Myr old clusters to search for transiting exoplanets. From the K2 light curves, we identified a planet orbiting a star in the Hyades star cluster. The planet is too light to measure the radial velocity variations with IGRINS alone. However, IGRINS is more than precise enough to rule out a stellar signal and put a light upper limit on the planet mass. The top Figure panel shows our IGRINS RV measurements phased to the planetary orbital period (3.84 days) along with the expected signal from a Neptune, Jupiter, and 3x Jupiter, while the bottom panel shows the same RVs phased to the stellar rotation period (1.88 days). More details can be found in the full paper (http://adsabs.harvard.edu/cgi-bin/bib_query?arXiv:1512.00483).



IGRINS Datacube of Orion KL Shocked Outflow

Heeyoung Oh, Tae-Soo Pyo, Kyle Kaplan, In-Soo Yuk, Dan Jaffe, and IGRINS Team

Orion KL (Kleinmann--Low) nebula is explosive outflow with more than 100 of high-velocity fingers. Intense shocked emission from this dense ISM is observed in ro-vibrational H_2 transitions. With IGRINS slit-scanning observations, we constructed 3-dimensional datacube of more than 30 H_2 emission lines at ~15″x15″ area at H_2 peak1 (Beckwith et al. 1978). This allows us to probe shock excitation in position-velocity resolved space. Here we report on the kinematics of bow shock fingers identified in our field. From the channel maps of H_2 1-0 S(1) line, we identified about 30 distinct finger patterns. Their features show good agreement with those in high special resolution image taken by Gemini observatory (Figure 1). The directions of fingers are almost parallel to the large scale vectors (Bally et al. 2015). In velocity profile, every finger knot shows multiple peaks at low-velocity and higher-velocity at blue or redshifted side. The peak intensity is always dominant at low-velocity, indicating the velocity profiles well represent the typical bow shock feature expected from the model of Hartigan et al. (1987), while the contribution of different excitation process on the profile should be considered. In position-velocity map, the velocity gradients of higher-velocity components ($|v_{\rm peak}|$ = 40–130 km s^{-1}) are similar in different fingers, with the decelerating rate of 2–6 km s^{-1}/″ from fingertip (Figure 2). This decelerating rate agrees with the value expected from the proper motion variation along the distance from source (Doi et al. 2002; Bally et al. 2011), which is ~4 km s^{-1}/″. By estimating the intrinsic velocity of each finger and its inclination angle, we can construct 3-dimensional map showing the distribution of the fingers in space.

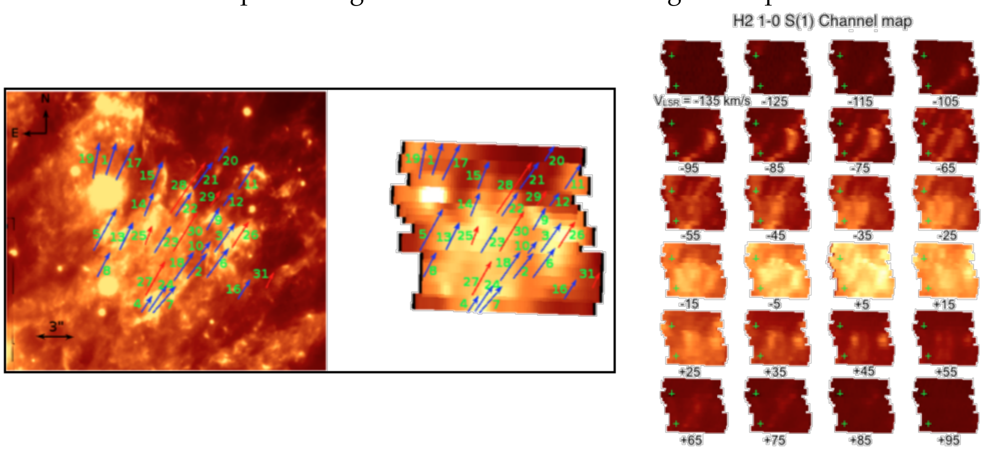


Figure 1. (Left) High spatial resolution H_2 1-0 S(1) image by Gemini GSAOI (Bally et al. 2015) and IGRINS slit-scan image of H_2 1-0 S(1) line integrated in radial velocity (V_{LSR}) range of ±150 km/s. The blue and red arrows mark the outflow streams found in our channel map at blueshifted and redshifted velocity, respectively. The finger numbering increase with radial velocity from -130 to +80 km/s. (Right) Channel map of H_2 1-0 S(1) line.

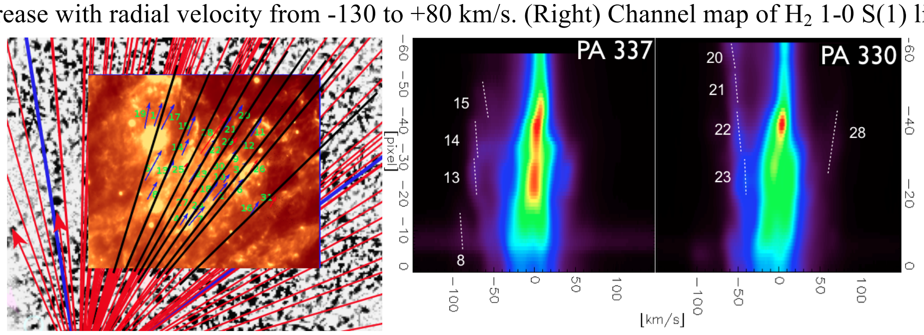
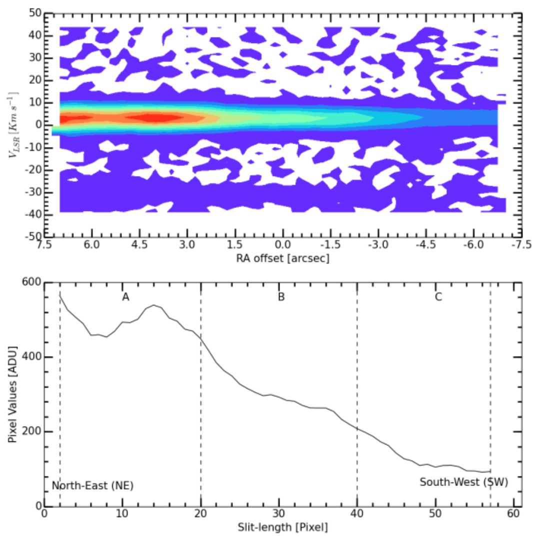


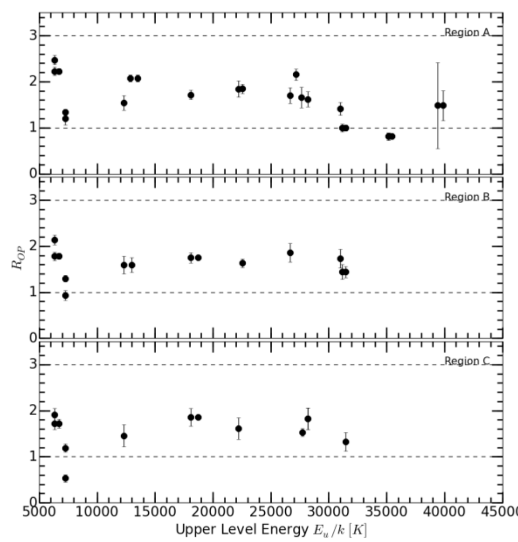
Figure 2. (Left) Comparison between large scale flow direction in Bally et al. (2015) and vectors identified from IGRINS observation. Black lines correspond to PA of 343, 337, 333, 330, 327, 325, 322, 320, and 314 degree (left to right). PVDs of fingers at PA of (center) 337 and (right) 330 degrees.

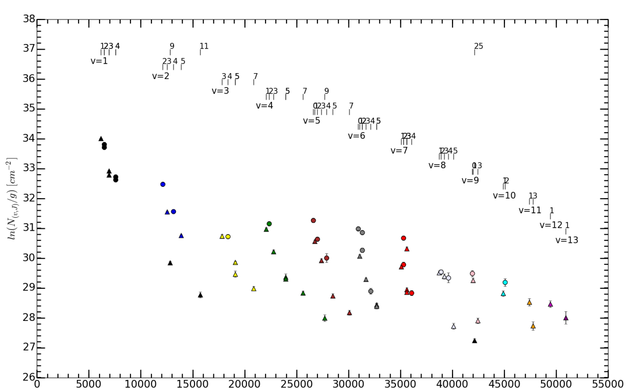
Molecular Hydrogen in NGC 7023:
Observations with Near-Infrared High-Resolution Spectroscopy of IGRINS

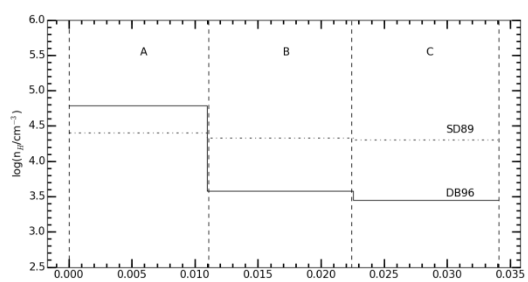
Huynh Anh Le, Soojong Pak, Dan Jaffe, Kyle Kaplan, Young Chol Minh, & Sungho Lee

The high-resolution spectra of near-infrared H2 emission lines from the northern filament of the refection nebulae, NGC 7023, are presented. The observed region is within the slit-length of 15”. We divided the observed region into three parts based on the 1-0 S(1) line strengths. We obtain 46-66 H2 emission lines, vibrational states in v=1-13 in each region. The column density of each ro-vibrational state from the measured H2 emission lines is calculated. The estimate ortho-to-para ratios (OPR) are 1.57-1.62. The OPR indicates that the H2 emission in the observed regions arises from UV fluorescence. We see the variations of OPR in all regions. The region which has higher OPR value may has more contribution from thermal excitation than that of other regions. We derive the hydrogen density of ~ 10^4 cm^{-3} by comparing the line ratio 2-1 S(1)/1-0 S(1) with that of Sternberg & Dalgarno (1989) model. Through the best-fits of observed line ratios to that Draine & Bertoldi (1996), we found the variations of density distribution in the observed regions. This results suggest that the observed regions has clumpy structure which high density clump ~10^5 cm^{-3} embedded in lower density regions, 10^3-$10^4 cm^3$. The estimate size of a clump may be ~ 0.01 pc.









The H_2 abundance in molecular clouds
John Lacy, Chris Sneden, Hwihyun Kim, Dan Jaffe

We are continuing to make progress on observations of H_2 and CO absorption toward sources in and behind molecular clouds. The goal of the project is to determine the H_2 and CO abundance ratio and the N_{H2} to A_v ratio in molecular clouds. We have a clear detection of H_2 S(0) absorption, H_2 S(1) emission, and CO v=2-0 absorption toward GL 989, a massive young star embedded in the Monoceros cloud. This has been observed before, but the advantage of IGRINS is that we also get to observe H_2 Q-branch emission, which allows us to correct the S(0) absorption line for overlapping emission. (Q(2) and S(0) share the v=2, J=2 upper level.) The derived H_2 / CO abundance ratio is 2500-5000, well below the usually assumed ratio of 10,000. We also have likely detections of H_2 absorption toward three stars behind the Taurus and Ophiuchus molecular clouds. We shouldn't have to worry about H_2 emission toward these objects, but we will have to divide out their complicated photospheric spectra. This should be completed soon.