IGRINS Newsletter -- 2015 Trimester 3

Dear IGRINS community:

IGRINS is now returning to McDonald after 6 weeks of annual maintenance at UT. During this maintenance period light leaks in the H and K band echellograms were greatly reduced and a new coldhead was installed. IGRINS has now had 170 nights at McDonald Observatory since commissioning and is scheduled for 57 more nights in the remainder of 2015T3. In this edition of the newsletter we report the current instrument status, remind observers of their obligations when requesting IGRINS time, and discuss the success of the 2015T3 mini-queue completed in early August 2015.

The next proposal deadline is September 30th, 2015, at 8am CDT for 2016T1. 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 September 23rd so they can be reviewed for feasibility ahead of the proposal deadline (September 30th).** Proposals that meet these early deadlines do remarkably better with the TAC.

A second mini-queue will be available in late January 2016 with a request deadline of ***January 11th, 2016****. A reminder will be distributed about two weeks before then.*

Dr. Chan Park's SPIE proceedings for IGRINS commissioning (http://adsabs.harvard.edu/abs/2014SPIE.9147E..1DP) have been published and should guide your feasibility of observations. Version 3 of the Exposure Time Calculator now provides the best estimates of IGRINS performance on the 2.7m (http://irlab.khu.ac.kr/~igrins/). The average telescope pointing time is ~10 minutes per target.

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

Annual maintenance was completed in August 2015, with IGRINS in the lab at UT. We replaced the coldhead as a preventative measure to avoid an unscheduled failure at the observatory. We added baffling inside the cryostat to reduce light leaks near the H and K detectors. Our ThAr arc lamp burned out in June 2015 and we are actively testing new lamps and ordering spares – this has minimal impact on future observations. After the maintenance we verified that alignment and focus are the same as during the first year of operation. IGRINS will be delivered back to McDonald Observatory on September 17th for observations throughout the next three trimesters. Thanks are owed to Chan Park, Jaesok Oh, Greg Mace, and Hwihyun Kim who played major roles in the maintenance effort.

The Pipeline Package is continuing to be developed by Dr. Jae-Joon Lee (https://github.com/igrins/plp/wiki). An updated version of the pipeline is in beta testing and will be released soon. This new version will include 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 (e.g., IGRINS observability), 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 at all times. This is to ensure safe operation and efficient use of the awarded time. We will continue to supply the IGRINS observer at team expense. 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 Success from August 2015

The first IGRINS mini-queue was scheduled from August 3rd through 6th, 2015. Adam Kraus and Chris Sneden added their nights to the queue, for eight total nights. The primary IGRINS observer was Kyle Kaplan. The nights ranged from clear to partly cloudy in weather, and the mini-queue observing format allowed the flexibility to work around poor weather. There were 14 proposals for the IGRINS mini- queue along with the targets added to the queue for Chris Sneden and Adam Kraus. 13 out of 14 of the proposed IGRINS mini-queue projects got data and 10 projects got all their requested observations. Overall, we have demonstrated the success and scientific efficiency of the IGRINS mini-queue and look forward to offering it again in January 2016.

5. IGRINS Mini-Queue Proposals for Janaury 2016

Following the success of the 2015T3 mini-queue in early August 2015, we plan to hold another mini-queue in January 2016. IGRINS is not a queue instrument, and we do not want programs to rely on this operation mode. The mini-queue is available to finish ongoing projects, complete short studies, and test new methods. **IGRINS queue requests can be made at any time, but the next deadline is January 11th, 2016.**

The top priority queue requests are those that are completing TAC approved programs and they are ranked by their TAC scores. Second priority goes to short studies that can yield results with just a couple hours of observing time. Final priority goes to exploratory projects. Short and exploratory projects are ranked by difficulty and are generally scheduled based on observing conditions. The earlier a queue request is made, the higher the chance is of making it into the queue time. If additional observers

are needed to support queue observations, then people will be drafted from the pool of queue requests.

The proposal for mini-queue time should include:
PI name/Institution
Email address
Type of proposal (1=finish existing program; 2=exploratory program; 3=short program)
Object name and coordinates
Instructions for observations (e.g. nods, slit PA, S/N, exposure time)
If type 1 proposal, give trimester designation (e.g. 2015-2) and
proposal number for program you are completing and include the ORIGINAL abstract
For type 2 or 3 proposal, list IGRINS team member collaborator
For all proposals, give a 1/2 page science justification

For any of the three types of observations, please send the proposal via email, as a pdf, to Anita Cochran (**anita@astro.as.utexas.edu)**. The subject of the email should include "IGRINS mini-queue" and your name.

6. IGRINS Science Meeting in Korea

The first IGRINS Science Workshop is scheduled for early November in Seoul, Korea. The meeting format will be a working meeting focusing on collaboration and IGRINS data analysis techniques. There will be a two-day Science Symposium including review science talks, technical talks, and contributed talks based on IGRINS results and future projects. People interested in attending should contact Dan Jaffe or Jae-Joon Lee.

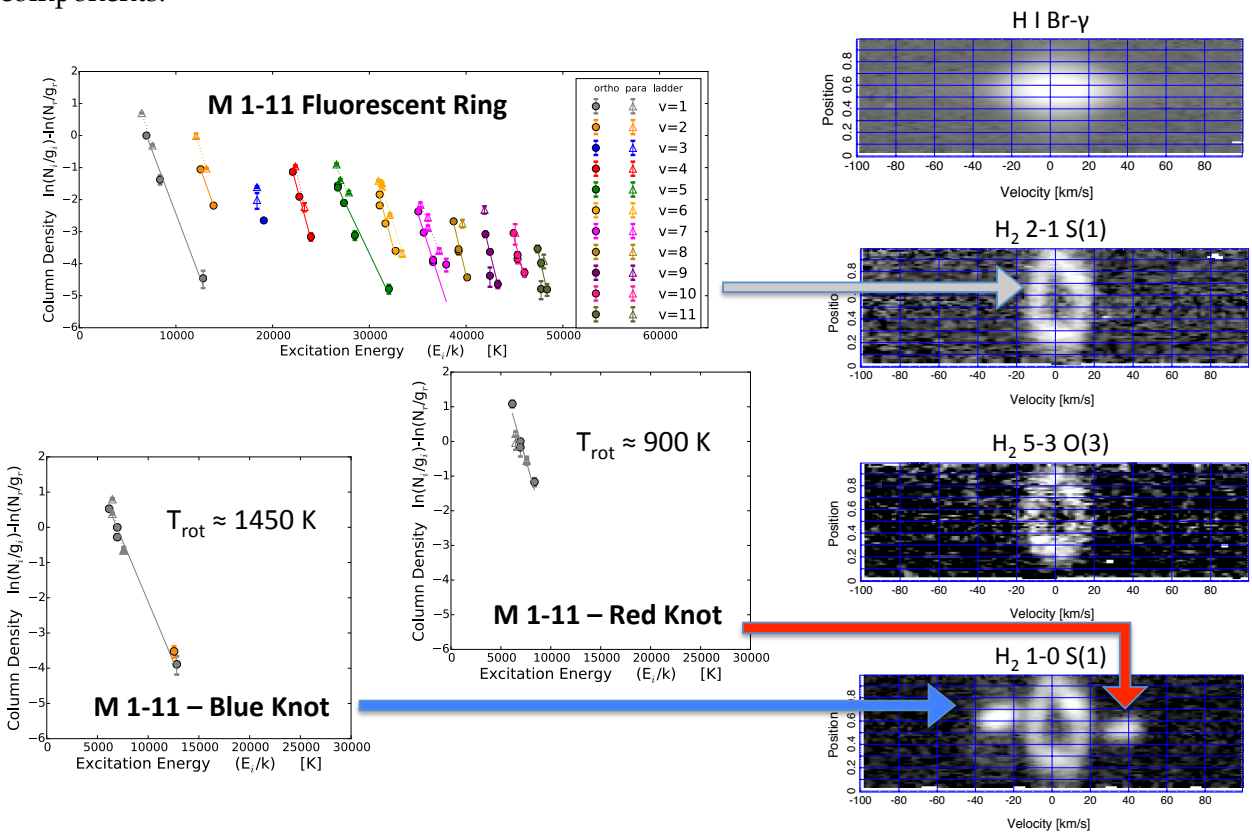
Science Highlights:

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.

H_2 Excitation in Planetary Nebulae

Kyle Kaplan, Harriet Dinerstein, and Dan Jaffe (UT)

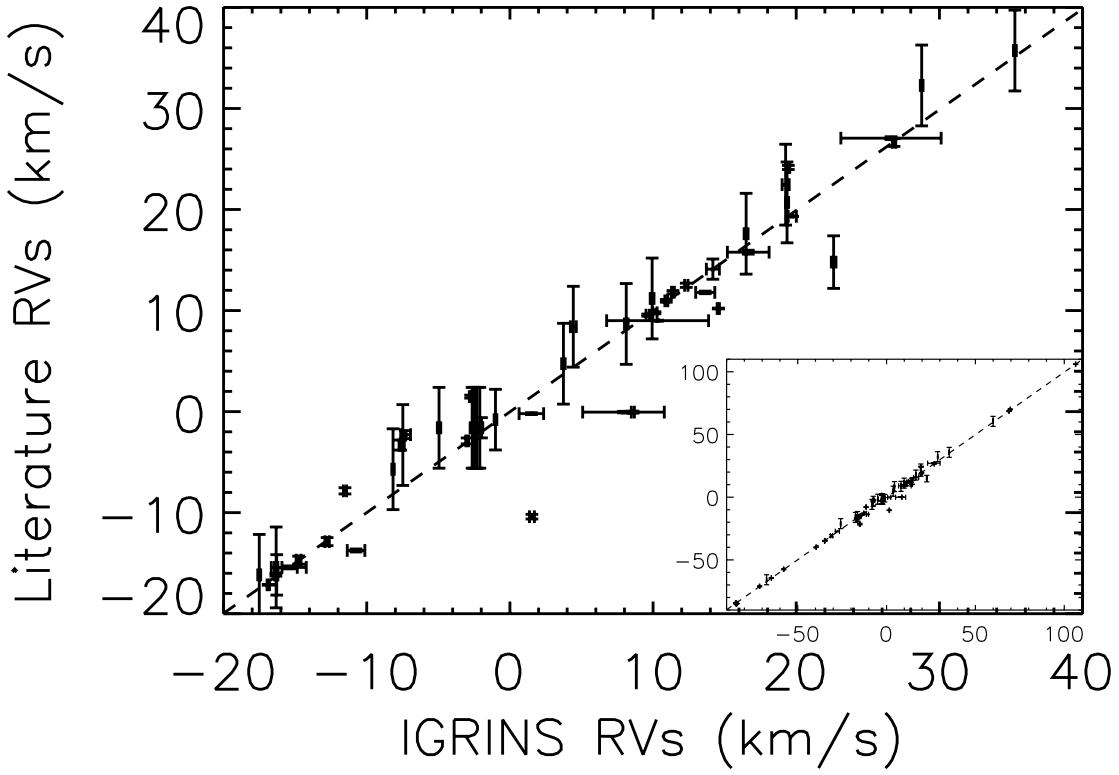
Planetary Nebulae (PNe) are extended circumstellar envelopes around hot stars, composed of material expelled by the stars during their evolution. PNe often contain molecular as well as ionized gas, as demonstrated by the presence of IR emission from vibrationally-excited H_2. In this environment more than one mechanism is available to excite H_2: there may be thermal emission from shock zones at interfaces between differentially expanding layers, or population of excited vibrational levels by radiative decay from higher electronic states after absorption of UV photons. In thermal gas the column densities in the excited levels obey the Boltzmann law, so the excitation diagram (if isothermal) is fit by a straight line, whereas excitation by UV radiation overpopulates higher energy states, yielding a distinctive sawtooth pattern. Some PNe are intermediate between the thermal and fluorescent cases, perhaps due to collisional modification of the level populations in dense gas or to the superposition of thermal and fluorescent components. We show here IGRINS observations of the PN M 1-11. 2-D snapshots of selected lines (below right) reveal intriguing structures in position-velocity space. The ionized gas, traced by Br γ, is compact and spans a wide velocity range. A smooth shell of H_2 emission surrounds the ionized gas. The excitation diagram for the ring (below left) is a prime example of fluorescent H_2, extending to levels with v = 11. In contrast, two knots of higher velocity H_2, not seen in any lines from v > 2, are consistent with thermal excitation and likely shock-excited (bottom left). The blue-shifted knot is brighter and hotter than the red-shifted one. These observations illustrate the ability of IGRINS to disentangle physically distinct H_2 components.



Stellar Radial Velocities with IGRINS

Gregory Mace, Dan Jaffe (UT Austin)

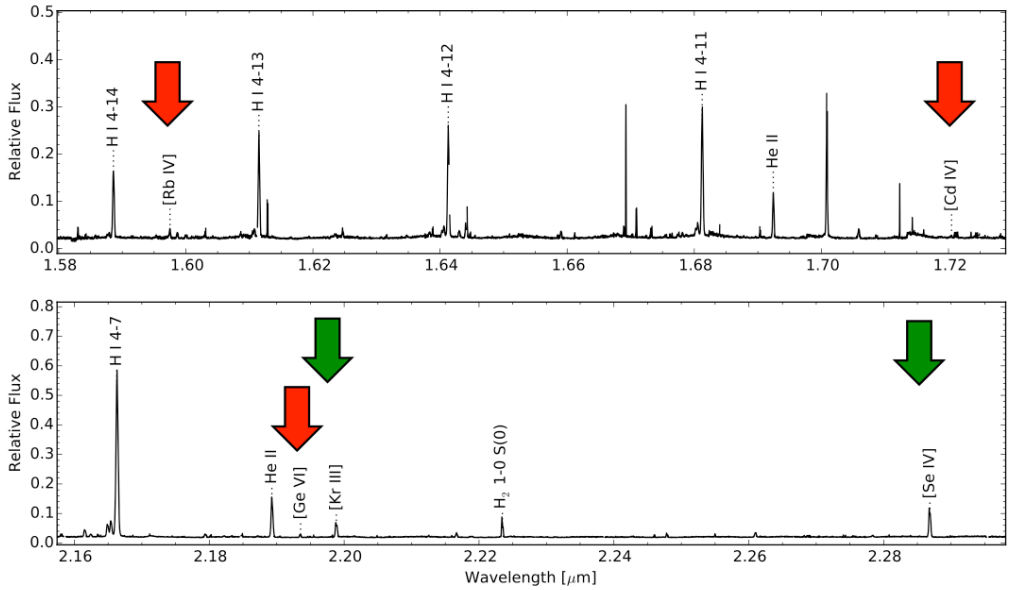
Radial velocities of M and L dwarfs are the missing component of most moving group studies. Radial velocities precise to ~1 km/s can verify group membership, but RV precision lower than 200m/s is required to find missing brown dwarf companions or moderate separation binaries. We can cross correlate any F through L dwarf observed with IGRNS to produce statistically robust radial velocities with median uncertainties of ~150m/s (0.1 pixels), and as low as 50 m/s (0.025 pixels). The precision is increased in cases where the signal-to-noise ratio is larger and the number of comparison spectra is greater. Precision is limited by additive uncertainties in the instrument flexure, cross-correlation function, and relative offsets from all template spectra. We have cross correlated more than 200 nearby stars and brown dwarfs and determined radial velocities consistent with the literature (primarily Chubak et al. 2012, arXiv:1207.6212). Outliers are known or candidate binaries that warrant further investigation. With these new radial velocities we can search for binaries using literature RVs as the first epoch of observation, update orbital parameters of known binaries, and test moving group membership.



Discovery of New IR Emission Lines from Neutron-Capture Elements with IGRINS

Harriet Dinerstein (UT), N.C. Sterling (Univ. W. Georgia), and Kyle Kaplan (UT)

Planetary nebulae (PNe) are comprised of gas cast off by low to intermediate-mass stars near the ends of their nuclear-powered lives. The chemical composition of a planetary nebula bears the imprint of all prior nuclear and mixing processes in the stellar interior, which may include slow neutron-captures (the s-process) that produce trans-iron nuclei during the Asymptotic Giant Branch phase. Two K-band emission lines first seen in PNe in 1976 were identified by Dinerstein (2001) as originating from Se (Z=34) and Kr (36). These lines were used in a survey of a large sample of Milky Way PNe that established the distribution of abundances and self-enrichments of Se and Kr (Sterling & Dinerstein 2008; Sterling, Porter, & Dinerstein 2015). We have used IGRINS to achieve the first detections of infrared emission lines of three additional elements – Ge (32), Rb (37), and Cd (48) – all detected in at least two PNe. Each of these species provides constraints on nucleosynthesis in the progenitor stars, which span a range of initial mass and metallicity. For example, Rb is more strongly enriched in higher-mass stars, where neutrons from the $^{22}Ne(\alpha, n)^{25}Mg$ reaction rather than $^{13}C(\alpha, n)^{16}O$ dominate, and Cd belongs to the second or "heavy" s-process peak, which is more enhanced relative to "light" s-process species (such as Se and Kr) in stars of lower metallicity (specifically [Fe/H]). Our analysis of the IGRINS spectra (Sterling et al., in preparation) incorporates new atomic data, calculated by Sterling and our collaborator Manuel Bautista (W. Mich. Univ.), that will enable us to determine accurate elemental abundances from the newly discovered lines.



Shown above is an IGRINS spectrum of the bright PN NGC 7027 from September 2014. The previously identified [Kr III] and [Se IV] lines are marked with green arrows, and the newly detected [Rb IV], [Cd IV], and [Ge VI] lines are indicated with red arrows. Our preliminary findings are that Rb is enhanced over solar by a factor of a few (similar to Kr), and that Cd is probably also enhanced but has a larger uncertainty.

References: Dinerstein 2001, ApJ, 550, L223; Sterling & Dinerstein 2008, ApJS, 174, 158; Sterling, Porter, & Dinerstein 2015, ApJS, 218, 25

Publication policy

Observing PIs are expected to analyze and publish their data promptly. It is up to each observing group to determine the number and type of publications to produce from any observing run.

Decisions about authors and author orders of general 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.

When several groups are working on similar science programs, the IGRINS team will try to inform the groups of this fact. While we encourage appropriate collaboration and data-sharing between groups, it is up to the groups themselves to make such arrangements.

The IGRINS team will archive IGRINS spectra. The current proprietary period is 24 months from the date the data are taken. At the discretion of either the UT or KASI PI's, this period can be extended for up to 36 months upon request for graduate students who have not yet completed their dissertation. Observing groups, will be subject to the policy that was in place at the time their observing time was awarded.

Refereeing:

The IGRINS team will have 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. The PI or a designee will serve as IGRINS editor. First authors should submit papers that are ready for publication to the IGRINS editor in pdf form. Comments and suggestions will be sent to the author within 3 weeks. Revisions in response to these comments can be made at the discretion of the authors but there will be no further review.

Authors should inform the IGRINS editor of the acceptance of *all* papers, refereed and non-refereed, at the time of acceptance, giving the title, journal, volume, and author list.

Acknowledgements:

Any paper using IGRINS science or engineering data must reference the designated IGRINS instrument paper(s):
Park, C. et al., "Design and early performance of IGRINS (Immersion Grating Infrared Spectrometer)," Proc. SPIE 9147 (2014).

Authors should inquire of one of the PIs about the appropriate references and the recommended form of the acknowledgement at the time of submission. Currently, the correct acknowledgement reads:
"This work used the Immersion Grating Infrared Spectrograph (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 grant AST-1229522, of the University of Texas at Austin, and of the Korean GMT Project of KASI."

Talks and Colloquia:

The IGRINS editor should be informed of any IGRINS conference talks or colloquia given by team members or observing PIs. No approval is needed for talks about one's own results. Review talks or summary talks about IGRINS results or instrument performance, however, should have approval of the PI of the speaker's team.