IGRINS RV: A Python package for precision radial velocities with Near-Infrared Spectra

Shih-Yun Tang[1,2]**, Asa G. Stahl**[3]**, Christopher M. Johns-Krull**[3]**, L. Prato**[1,2]**, and Joe Llama**[1]

1 Lowell Observatory, 1400 W. Mars Hill Road, Flagstaff, AZ 86001, USA **2** Department of Astronomy and Planetary Sciences, Northern Arizona University, Flagstaff, AZ 86011, USA **3** Department of Physics and Astronomy, Rice University, 6100 Main Street, Houston, TX 77005, USA

Summary

The relative velocity of a star to the Sun can be calculated from its electromagnetic spectrum using the Doppler Effect. This line-of-site relative velocity, called the Radial Velocity (RV), has been an essential tool for astrophysicists. RVs are not only used to detect and characterize exoplanets, but also play a key role in studies of binary stars, star clusters, and moving group member identification.

In the past decade, RVs have mostly been measured from spectra in the optical wavelength regime. This is partly because of advancements in detector technology, but also because of the paucity of Earth's atmospheric absorption features (telluric lines) in the optical. Yet, a fainter, cooler stellar object emits more energy in the NIR, like an M type star (stars with mass less than half of the Sun), observation in the NIR can save lots of exposure time. Also, the number of small staller objects is larger than those of the Sun-like stars, this along with its size, increases the detectability of Earth-like planets around them. Moreover, the fake planet like RV signal, e.g., dusk accretion on to the stellar surface or sun spots rotation period, is shown to be less server in the NIR compared to optical.

`IGRINS RV` is a pipeline built for extracting precision RVs from spectra taken with the Immersion GRating INfrared Spectrometer (IGRINS) spectrograph (Mace et al., 2016, 2018; Park et al., 2014; Yuk et al., 2010). This pipeline is built on the forward-modeling methodology that was successfully applied to CSHELL and PHOENIX spectra in the past (Crockett et al., 2012). However, `IGRINS RV` gives three times better RV precision to about 25–50 m/s shown by yearlong monitoring on two RV standard stars, GJ 281 and HD 26257. This improvement is because of the use of a more robust approach to wavelength calibration and a better telluric modeling. `IGRINS RV` also shown its ability to search hot Jupiters by successfully recovers the planet induces RV signal from HD 189733, and Boo A. `IGRINS RV` lets users choose to obtain absolute RVs or relative RVs, depending on whether their priority is precise RV monitoring or more coarse RV characterization. `IGRINS RV` requires `igrins plp v2.2` (Lee, Gullikson, & Kaplan, 2017) and `Telfit` (Gullikson, Dodson-Robinson, & Kraus, 2014) package pre-installed. Detailed documentation and tutorials can be found on the GitHub wiki page.

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