# The Resurgence of High Resolution Spectroscopy at Gemini

A splinter session at the 2019 Winter AAS

Sponsored by the NOAO US National Gemini Office

Kenneth Hinkle, moderator

http://ast.noao.edu/csdc/usngo

# High Resolution Spectroscopy at Gemini

- High resolution spectroscopy was part of original instrumentation plan
- A first light instrument was to be the High Resolution Optical Spectrograph (HROS)
- Design problems -> Resulted in delayed deployment of a bench mounted version (bHROS)
- Lack of demand resulted in decommissioning bHROS

# bHROS

## 0.4 – 1.0 $\mu$m, 2500 km $s^{-1}$, R~140000

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### MEASUREMENTS OF THE ISOTOPIC RATIO $^{6}Li/^{7}Li$ IN STARS WITH PLANETS

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*Received 2009 February 10; accepted 2009 March 30; published 2009 May 20*

ABSTRACT

High-resolution ($R = 143{,}000$), high signal-to-noise ratio (S/N = 700–1100) Gemini-S bench-mounted High-Resolution Optical Spectrograph spectra have been analyzed in a search for $^{6}$Li in five stars which host extrasolar planets. The presence of detectable amounts of $^{6}$Li in these mature, solar-type stars is a good monitor of accretion of planetary disk material, or solid bodies themselves, into the outer layers of the parent stars. Detailed profile fitting of the Li I resonance doublet at λ6707.8 Å reveals no detectable amounts of $^{6}$Li in any star in our sample. The list of stars analyzed includes HD 82943 for which $^{6}$Li has been previously detected at the level of $^{6}Li/^{7}Li = 0.05 \pm 0.02$. The typical limits in the derived isotopic fraction are $^{6}Li/^{7}Li \leqslant 0.00$–$0.02$. These upper limits constrain the amount of accreted material to less than ~0.02–0.5 Jovian masses. The presence of detectable amounts of $^{6}$Li would manifest itself as a red asymmetry in the Li I line profile and the derived upper limits on such asymmetries are discussed in light of three-dimensional hydrodynamic model atmospheres, where convective motions also give rise to slight red asymmetries in line profiles.

*Key words:* line: profiles – planetary systems: formation – stars: abundances – stars: atmospheres

# Visitor spectrographs offered

- Initial offering was Phoenix and later TEXES
- Both are still offered

# TEXES
# 7 – 25 μm, 1500 km $s^{-1}$ intervals, R~4000&80000

The Astrophysical Journal, 658:L45–L49, 2007 March 20


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## W51 IRS 2: A MASSIVE JET EMERGING FROM A MOLECULAR CLOUD INTO AN H II REGION

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*Received 2006 October 24; accepted 2007 February 8; published 2007 February 23*

## ABSTRACT

We have mapped [Ne II] (12.8 μm) and [S IV] (10.5 μm) emission from W51 IRS 2 with TEXES on Gemini North, and we compare these data to VLA free-free observations and VLT near-infrared images. With 0.5″ spatial and 4 km $s^{-1}$ spectral resolution, we are able to separate the ionized gas into several components: an extended H II region on the front surface of the molecular cloud, several embedded compact H II regions, and a streamer of high-velocity gas. We interpret the high-velocity streamer as a precessing or fanlike jet, which has emerged from the molecular cloud into an OB star cluster where it is being ionized.

*Subject headings:* H II regions — infrared: ISM — ISM: jets and outflows

# Phoenix
# 1- 5 $\mu$m, 1550 km $s^{-1}$ intervals, R=50000 – 70000

CHEMICAL ABUNDANCES IN 12 RED GIANTS OF THE LARGE MAGELLANIC CLOUD FROM HIGH-RESOLUTION INFRARED SPECTROSCOPY[1]

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*Received 2002 August 9; accepted 2002 August 31*

## ABSTRACT

High-resolution infrared spectra ($\lambda/\Delta\lambda = 50{,}000$) have been obtained for 12 red giant members of the Large Magellanic Cloud (LMC) with the Gemini South 8.3 m telescope and Phoenix spectrometer. Two wavelength regions, at 15540 and 23400 Å, were observed. Quantitative chemical abundances of carbon (both $^{12}C$ and $^{13}C$), nitrogen, and oxygen were derived from molecular lines of CO, CN, and OH, while sodium, scandium, titanium, and iron abundances were obtained from neutral atomic lines. The 12 LMC red giants span a metallicity range from [Fe/H] = −1.1 to [Fe/H] = −0.3. It is found that values for both [Na/Fe] and [Ti/Fe] in the LMC giants fall below their corresponding Galactic values (at these same [Fe/H] abundances) by about ~0.1–0.5 dex; this effect is similar to abundance patterns found in the few dwarf spheroidal galaxies with published abundances. The program red giants all show evidence of first dredge-up mixing of material exposed to the CN cycle, that is, low $^{12}C/^{13}C$ ratios and lower $^{12}C$ with higher $^{14}N$ abundances. The carbon and nitrogen trends are similar to what is observed in samples of Galactic red giants, although the LMC red giants seem to show smaller $^{12}C/^{13}C$ ratios for a given stellar mass. This relatively small difference in the carbon isotope ratios between LMC and Galactic red giants could be due to increased extra mixing in stars of lower metallicity, as suggested previously in the literature. Comparisons of the oxygen-to-iron ratios in the LMC and the Galaxy indicate that the trend of [O/Fe] versus [Fe/H] in the LMC falls about 0.2 dex below the Galactic trend. Such an offset can be modeled as due to an overall lower rate of supernovae per unit mass in the LMC relative to the Galaxy, as well as a slightly lower ratio of supernovae of Type II to supernovae of Type Ia.

*Key words:* galaxies: dwarf — Magellanic Clouds

# New High Resolution Spectrographs

- GRACES – Offered now
- IGRINS – 2018A & Future
- Maroon-X – Near Future
- GHOST – In Construction