IRTF Near-Infrared Spectral Atlas. I. Wolf-Rayet Stars

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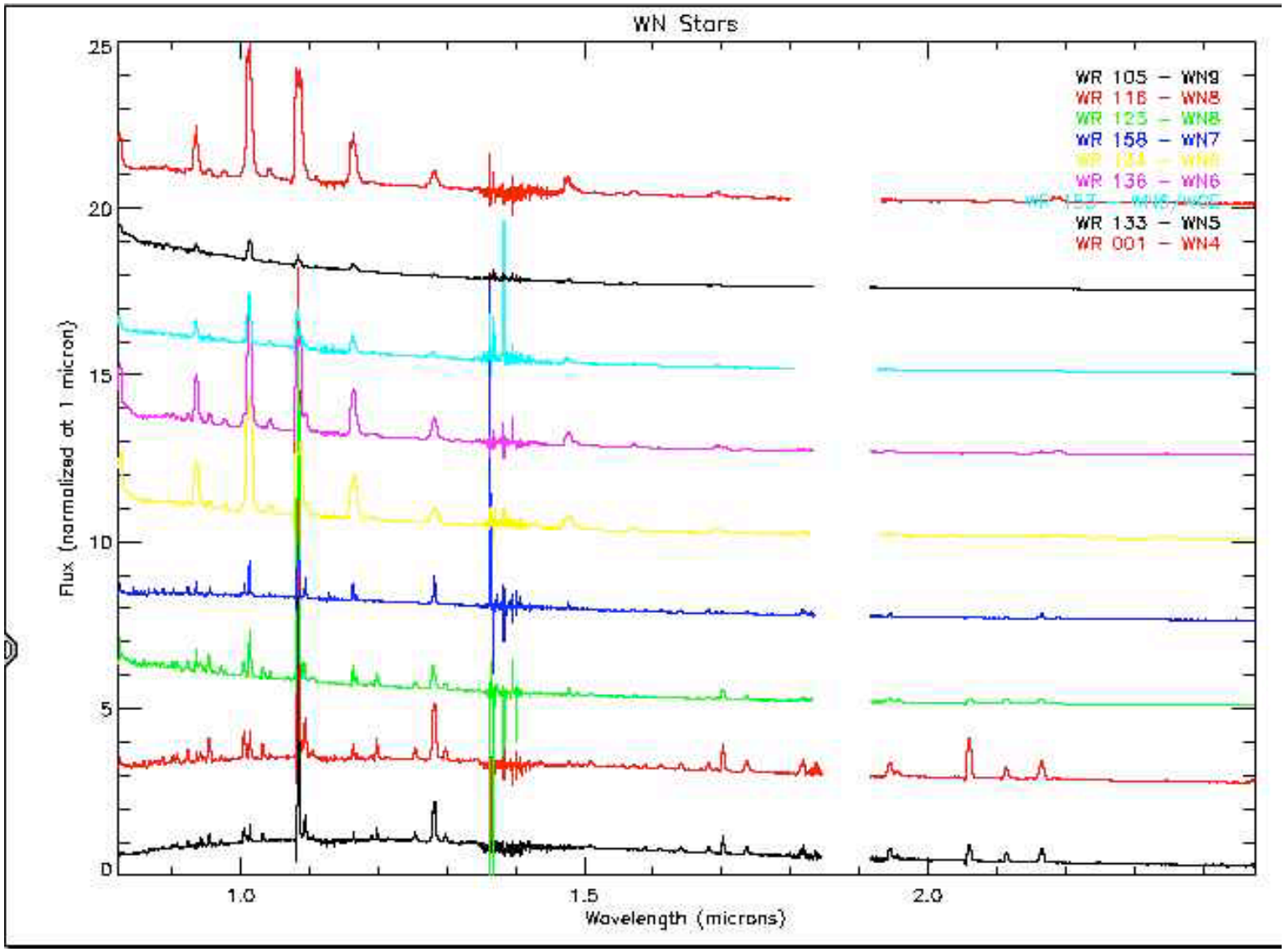
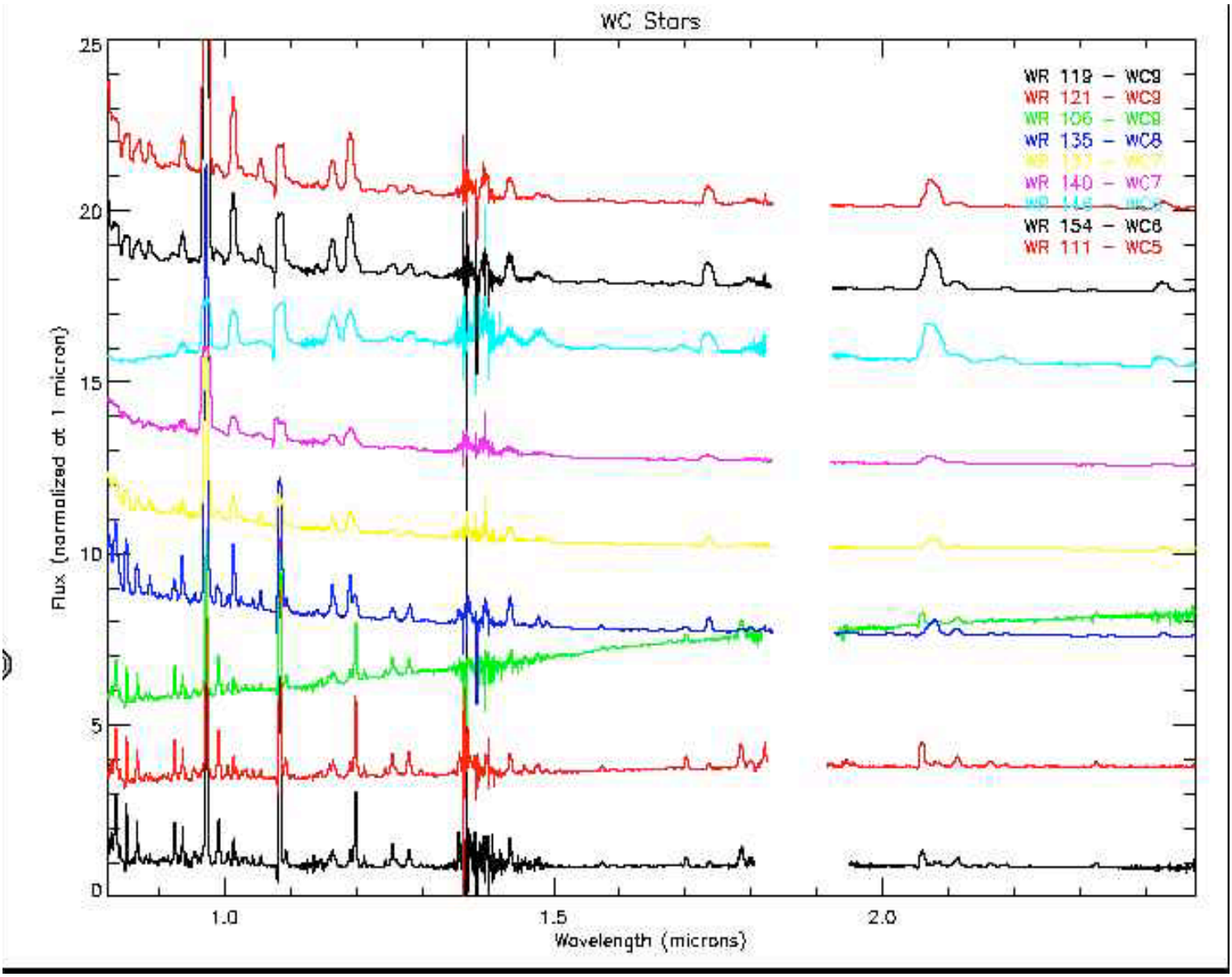
Wolf-Rayet (W-R) stars are the highly evolved descendants of the most massive O stars. These extreme Population I objects are hot and luminous, and exhibit spectra characterized by strong, broad emission lines resulting from dense, high-velocity stellar winds. There are two main types of W-R stars: WN, whose spectra are dominated by emission lines of helium and nitrogen, and WC, whose spectra exhibit strong emission features of helium, carbon, and oxygen.

While W-R stars have been observed and studied extensively in the ultraviolet and optical wavelength regimes, until recently relatively little work has been done on their near-infrared spectral properties, despite the fact that some of the strongest emission lines are expected to lie at λ>1 micron. SpeX has allowed us to remedy this situation, and we have carried out a program to acquire 0.8-5.0 micron spectra of a sample of 26 Galactic W-R stars. Our sample includes examples of all spectral subtypes. In addition, the combination of spectral resolution, wavelength range, and signal-to-noise, in our SpeX W-R data is unprecedented.

As seen in Figures 1 and 2, the NIR spectra of WN and WC stars are dominated by numerous strong emission lines of H, He I, He II, C III,and C IV. The He I lines at 1.0830 and 2.058 microns exhibit P Cygni profiles, typical of mass outflow in a strong stellar wind. Emission from circumstellar dust accounts for the red spectral slopes of some of the latest spectral subtypes, particularly the WC9 stars.

We are currently using the SpeX data to produce a NIR spectral atlas of W-R stars. The equivalent widths and relative strengths of the various emission lines in the Atlas should allow the identification and classification of W-R stars in star-forming regions heavily embedded in dust (e.g., in the Galactic Center, or IR-bright starburst galaxies) whose stellar populations can be studied only at NIR wavelengths. We are also combining these spectra with the latest W-R stellar atmosphere models to determine the properties of the W-R stars in our sample. This exercise should allow us to determine accurate estimates of the stellar radii, temperatures, luminosities, wind velocity parameters, mass-loss rates, and extinctions. Finally, the NIR SpeX data will be combined with existing optical and ultraviolet spectra of these W-R stars and incorporated into population synthesis models. This will allow more accurate modeling of the integrated spectra of very young starburst regions and galaxies.


WN Stars
WR 105 – WN9
WR 116 – WN8
WR 123 – WN8
WR 158 – WN7
WR 136 – WN6
WR 133 – WN5
WR 001 – WN4
Flux (normalized at 1 micron)
Wavelength (microns)
0
5
10
15
20
25
1.0
1.5
2.0


WC Stars
WR 119 – WC9
WR 121 – WC9
WR 106 – WC9
WR 135 – WC8
WR 140 – WC7
WR 154 – WC6
WR 111 – WC5
Flux (normalized at 1 micron)
Wavelength (microns)
0
5
10
15
20
25
1.0
1.5
2.0