J/A+A/603/A57 51 Eri b SPHERE/IFS spectra & atmosphere models (Samland+, 2017)

Spectral and atmospheric characterization of 51 Eridani b using VLT/SPHERE.
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ADC_Keywords: Stars, double and multiple ; Planets ; Spectroscopy ;
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methods: data analysis - techniques: high angular resolution -
techniques: image processing

Abstract:
51 Eridani b is an exoplanet around a young (20Myr) nearby (29.4pc) F0-type star, which was recently discovered by direct imaging. It is one of the closest direct imaging planets in angular and physical separation (~0.5", ~13AU) and is well suited for spectroscopic analysis using integral field spectrographs. We aim to refine the atmospheric properties of the known giant planet and to constrain the architecture of the system further by searching for additional companions. We used the extreme adaptive optics instrument SPHERE at the Very Large Telescope (VLT) to obtain simultaneous dual-band imaging with IRDIS and integral field spectra with IFS, extending the spectral coverage of the planet to the complete Y- to H-band range and providing additional photometry in the K12-bands (2.11, 2.25 micron).

We present the first spectrophotometric measurements in the Y and K bands for the planet and revise its J-band flux to values 40% fainter than previous measurements. Cloudy models with uniform cloud coverage provide a good match to the data. We derive the temperature, radius, surface gravity, metallicity, and cloud sedimentation parameter fsed. We find that the atmosphere is highly super-solar ([Fe/H]~1.0), and the low fsed~1.26 value is indicative of a vertically extended, optically thick cloud cover with small sized particles. The model radius and surface gravity estimates suggest higher planetary masses of $M_{gravity}=9.1^{+4.9}_{-3.3}$. The evolutionary model only provides a lower mass limit of $>2M_{jupiter}$ (for pure hot-start). The cold-start model cannot explain the luminosity of the planet. The SPHERE and NACO/SAM detection limits probe the 51 Eri system at solar system scales and exclude brown-dwarf companions more massive than $20M_{jupiter}$ beyond separations of ~2.5AU and giant planets more massive than $2M_{jupiter}$ beyond 9 au.

Description:
One fits file for each spectrum of 51 Eridani b (SPHERE IFS-YJ, IFS-YH, Samland et al., 2017, this work; GPI-H band, Macintosh et al., 2015, Cat. J/other/Sci/350.64). The first extension of the file contains the spectrum used in the paper (fits-table). The second extension contains the correlation matrix for the uncertainty of the spectral points (fits-image). The petitCODE (a self-consistent 1d radiative-convective equilibrium code, see Molliere et al., 2015ApJ...813...47M, 2017A&A...600A..10M) atmospheric model grids (cloudy and clear) as used and described in Samland et al. 2017, this work, are provided as fits-files. The first extension contains the wavelength sampling of the model cube at a resolution of 1000 (same for all models). The second extension contains the table of all model parameter combinations (each row one model, columns represent parameters). The third extension contains the flattened model cube as 2D-fits image (index of row of table in 2nd ext. corresponds to index of model in 3rd extension). The header of the 3rd extension gives the dimensions of the model cube prior to flattening to make it easy to restore the non-flattened shape if necessary. Units and descriptions can always be found in the respective headers.

Objects:

RA (2000)	DE	Designation(s)
04 37 36.13	-02 28 24.8	51 Eri = HR 1474

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
list.dat	94	5	List of fits files
fits/*	0	5	Individual fits files

See also:
J/other/Sci/350.64 : 51 Eri b near-infrared spectrum (Macintosh+, 2015)

Byte-by-byte Description of file: list.dat

Bytes	Format	Units	Label	Explanations
1- 2	I2	h	RAh	? Right Ascension of center (J2000)
4- 5	I2	min	RAm	? Right Ascension of center (J2000)
7- 11	F5.2	s	RAs	? Right Ascension of center (J2000)
13	A1	---	DE-	? Declination sign of center (J2000)
14- 15	I2	deg	DEd	? Declination sign of center (J2000)
17- 18	I2	arcmin	DEm	? Declination sign of center (J2000)
20- 23	F4.1	arcsec	DEs	? Declination sign of center (J2000)
25- 26	I2	Mbyte	size	Size of FITS file
28- 52	A25	---	FileName	Name of FITS file, in subdirectory fits
54- 94	A41	---	Title	Title of the FITS file

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