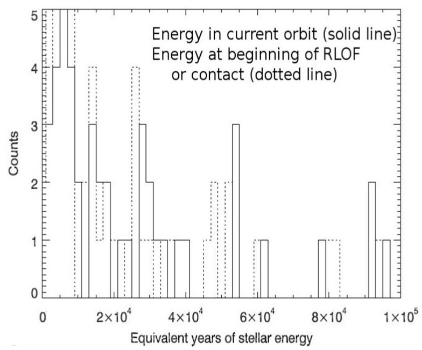
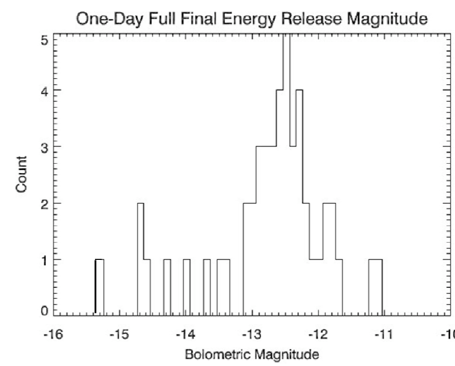
Observability of Planet Destruction: Fast Bangs or Slow Whimpers?

Massive planets have plenty of energy and gas to create observational signatures.

•Released gas observed (WASP 12)

•Luminosity increase not yet found



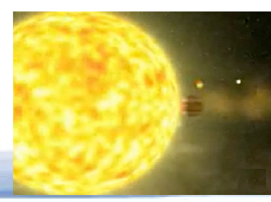


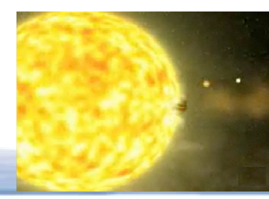
Orbital energies of the transiting planets, from current orbits (solid lines) and at the start of destruction (dashed). “Destruction” defined by whichever occurs first between Roche lobe overflow (RLOF) or collision with photosphere.

Nearby galaxy distance moduli:
M31 24.5
M81 27.8

LSST monitor to 18.5
SDSS-II to 15.5
Pan-STARRS 15
Pan-STARRS wide 12.5

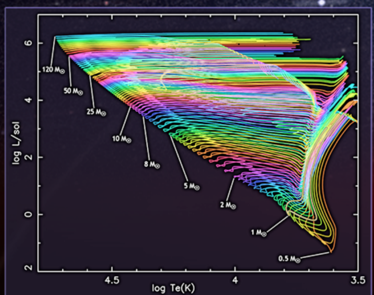
Stuart Taylor
National Tsing-Hua University
Taiwan





Evolution / Explosions of Massive Stars and Elemental Abundances in the Solar Neighborhood

Nahks Tr'Ehnl[1] — with F.X. Timmes[1], P.A. Young[1], M. Turnbull[2], S. Schmidt[1], and A.D. Anbar[1]
[1]Arizona State University School of Earth and Space Exploration, Tempe, AZ [2]Global Science Institute, Antigo, WI

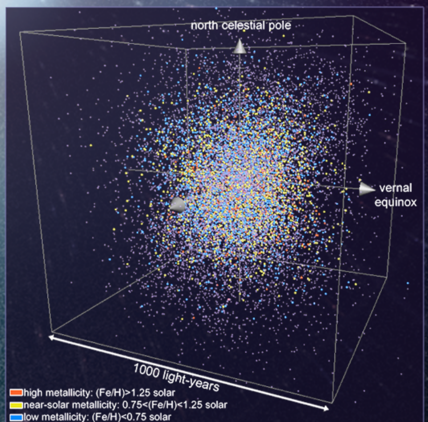


evolutionary tracks of stars with initial masses 0.5 - 120 $M_{\odot}$, evolved with TYCHO

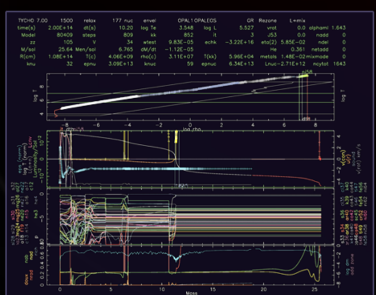
Exploring the effects of astrophysical phenomena on planetary system chemistry and habitability:

- Modeling the chemical and dynamical evolution of massive stars
- Supplementing the Catalog of Nearby Habitable Stellar Systems ("HabCat") with elemental ratios

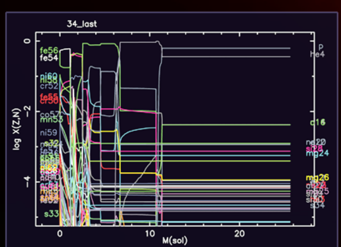
More on ASU Astrobiology: *http://astrobiology.asu.edu*

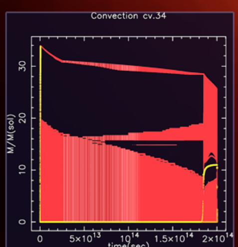


HabCat stars with Fe/H measurements within 500 lyr of the Sun

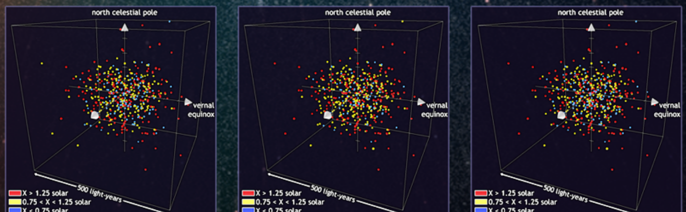


TYCHO stellar evolution code





composition and structure of a 34 $M_{\odot}$ (intial) star at core collapse



left to right: selected HabCat stars with Na/H, Si/H, and Ni/H measurements within 250 lyr of the Sun

Model For Exomoons Detection Using Transits

Luis Ricardo Moretto Tusnski
Advisor: Adriana Válio (Mackenzie University)
National Institute for Space Research - São José dos Campos, SP, Brazil

Main Objective:

Build a model to simulate a planet+moon transit in front of the host star.

Method:

The model, developed in IDL, simulates the star as a bright disk (with the corresponding limb darkening), whereas the planet and the moon are opaque disks. In each step, the program calculates the position of the planet and the moon, and estimates the star luminosity. The result is the lightcurve. The influence of dark spots on the stellar surface are also considered in the model.

Expected Results:

We expect to determine whether these moons are detectable, and establish the detection limits.

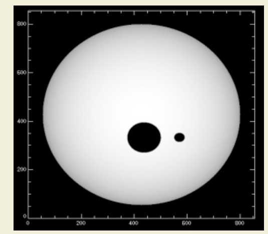


Figure: Transit of a planet similar to Corot-2b with a Moon.

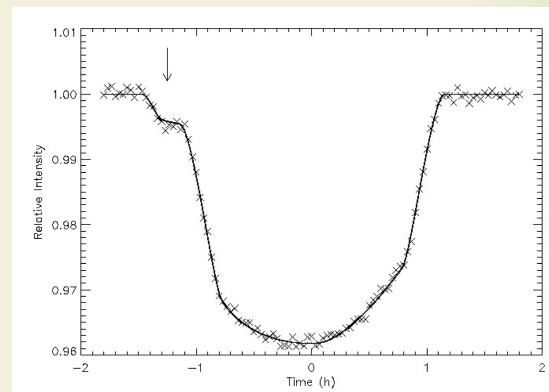


Figure: Lightcurve generated by the model.

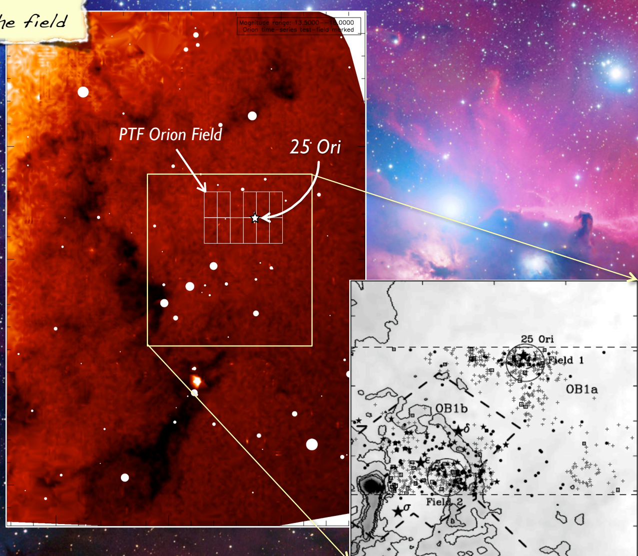
The PTF Orion Planet-Search

Julian C. van Eyken,[1,3] D. R. Ciardi,[1,3] R. L. Akeson,[1,3] C. A. Beichman,[1,3] A. F. Boden,[3] K. von Braun,[1,3] S. R. Kane,[1,3] P. Plavchan,[1,3] S. V. Ramírez,[1,3] L. M. Rebull,[2,3] J. R. Stauffer,[2,3] and the PTF collaboration.
[1]NExScI; [2]Spitzer Science Center; [3]Caltech

The PTF Orion project is part of the Palomar Transient Factory (PTF), a survey for astronomical transients being undertaken with a dedicated wide-field 12-CCD array installed on the Palomar 48" telescope.

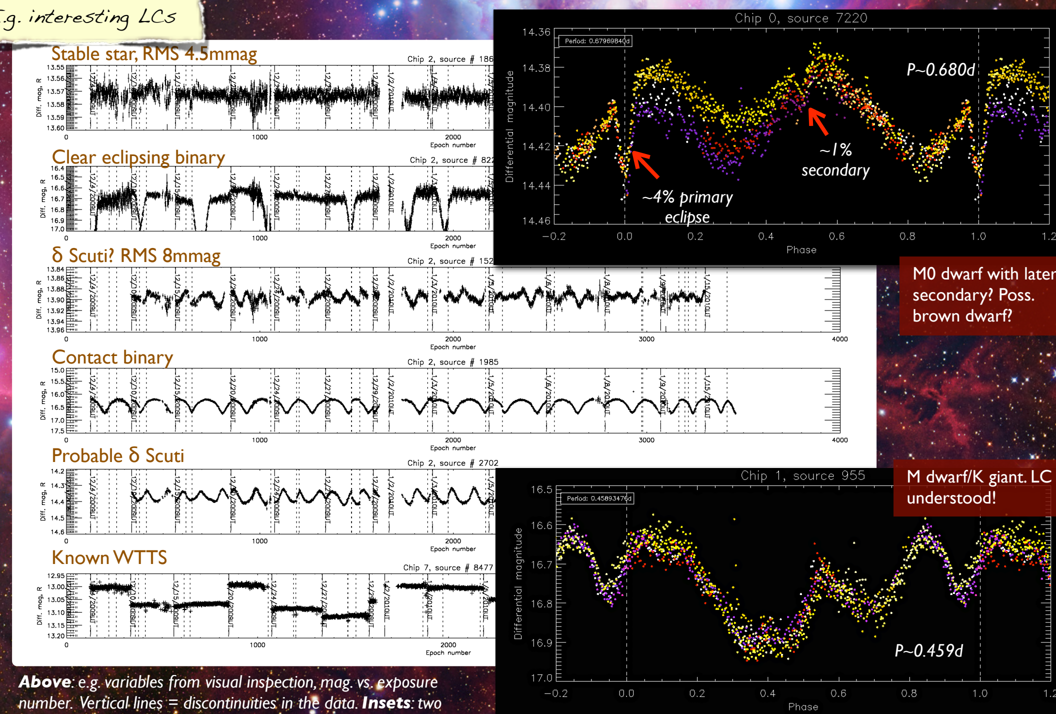
- *40 consecutive nights high-cadence data/yr for 3 years to*
  - *Detect Jupiter-sized planets transiting young stars*
  - *Study eclipsing binaries*
  - *Characterise stellar activity/rotation*
  - *Characterise new YSO's*
- *First year complete:*
  - *Single pointing toward 25 Ori, ~7-10 Myr old*
  - *~70-90s cadence, R-band*

The field



Known T-Tauris (Briceño et al. 2007)

E.g. interesting LCs



M0 dwarf with later secondary? Poss. brown dwarf?

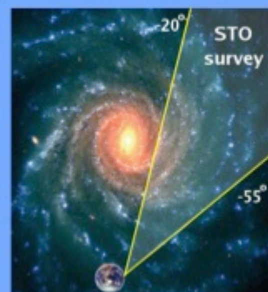
M dwarf/K giant. LC not understood!

Above: *e.g. variables from visual inspection, mag. vs. exposure number. Vertical lines = discontinuities in the data.* ***Insets***: *two interesting folded LCs.*

Stratospheric THz Observatory (STO)

ASU, UAz, JHU/APL, CIT/JPL, KOSMA, Ames, SAO, Oberlin , U.Maryland

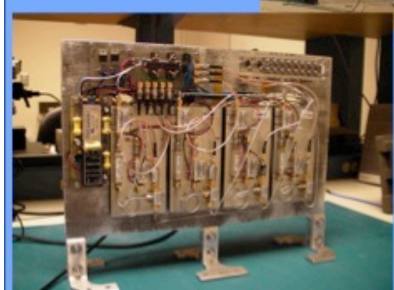
- 0.8-meter telescope with two
-4-pixel THz arrays
- platform for THz surveys



- LDB Platform
~30 day flights
-Antarctic Launch

2009 – First Engr. Flight

2011-12 - First Science Flight : C+, N+ Survey



STO Amplifier Box

Todd Veach
Arizona State Univ.

Detector Characterization and Testing

- Instrument Design:
  - Delta-doped CCD characterization
  - Currently working on a Modular Imaging Cell (MIC) design for a future mission
- Institutions:
  - JPL
  - ASU
- Science Interests:
  - Observe massive star forming regions in UV/ Visible wavelengths
  - Young Star Evolution
  - Debris Disks around young stars

Fundamental Parameters of Exoplanet Hosting Stars

Kaspar von Braun (NExScI / Caltech), Tabetha S. Boyajian (Georgia State U.), Gerard T. van Belle (ESO), David R. Ciardi (NExScI / Caltech), Stephen R. Kane (NExScI / Caltech), et al.

Why?

- Formation & evolution of exoplanets are heavily influenced by the properties of their parent stars.
- Radiation environment affects exoplanet surface temperature and weather (heat redistribution efficiency).
- Astrophysical properties of parent stars determine location and extent of the system's habitable zone.

How?

- ***Linear Radii*** from Hipparcos distances and interferometrically measured angular diameters (using PTI and CHARA).

$$R_{linear} \sim D * \theta$$

- ***Effective Temperatures*** from angular diameters and bolometric flux, calculated from spectral energy distribution fitting to literature photometry data.

$$T_{eff} \sim (F_{bol} / \theta^2)^{1/4}$$

- ***Stellar Masses*** from literature log g estimates and linear radii.

$$\log g \sim \log (G * M_{star} / R^2_{linear})$$

Status: published radii and temperatures of 9 exoplanet host stars (van Belle & von Braun 2009) based on PTI data. Paper on several much smaller KM-dwarf planet hosts (CHARA data) later this year.

Ground-based spectroscopy of exoplanetary atmospheres

Introduction:

With the rapid increasing number of transiting extrasolar planets discovered, the characterisation of their atmospheres becomes feasible for more and more of these peculiar worlds. The use of transmission (when the planet eclipses its host star) and emission (when the planet passes behind the star) spectroscopy in the near-infrared has been highly successful in the characterisation of exoplanetary atmospheres. Several molecules, such as water, methane, carbon-dioxide and monoxide have been discovered on several transiting exoplanets till date (Swain et al. 2008, 2009a, 2009b, Grilmair et al. 2008, Tinetti et al. 2007, 2010). These discoveries were pioneered using space based facilities such as HST and Spitzer. However, in the light of a rapidly increasing target list and time availability restrictions for space-based observatories, increasing efforts using available ground-based telescopes becomes essential.

Observational strategy:

In order to be able to disentangle the exoplanetary atmosphere spectrum from that of its host star and the stochastic contribution of our own atmosphere, we follow a 'photometry approach' to spectroscopy. Taking consecutive, relatively short exposure time spectra, we obtain a time coverage of the eclipse feature. This includes sufficient out-of-transit data to establish a baseline. Using this approach we obtain a timeseries data-set for each individual spectral channel. The varying eclipse depths for different spectral channels comprise the atmospheric spectrum of the extrasolar planet.
Due to the strong presence of stellar, telluric and instrumental noise, the eclipse feature is often buried under the noise present. In these cases the signal can still be recovered using statistical methods such as self-coherence.

References:

Grillmair et al. 2008, Nature, 456, 767; Pagiatakis et al., 2007, Phys. Earth and Planet. Interiors, 160, 108; Swain et al. 2008, Nature, 452, 329; Swain et al. 2009a, ApJ, 704, 1616; Swain et al. 2009b, ApJ, 690, L114; Swain, M. R.et al., 2010, Nature, 463, 637; Tinetti et al. 2007a,Nature, 448, 169; Tinetti et al. 2010, ApJL, 712, L139; Waldmann et al., MNRAS submitted; Waldmann et al in prep.

Self-coherence method:

In an idealised case where all noise present in the data can be assume to be random (white), the stacking of several timeseries data-sets is very effective in reducing the noise contribution by √N. This approach breaks down when the noise present is not Gaussian. In these cases we need to 1) reduce the invariable, systematic noise present and 2) use self-coherence to extract the signal out of a group of common timeseries sets.

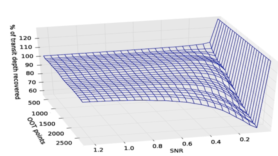
It is defined as the consecutive convolution of timeseries sets with sets of adjacent spectral channels. In these repeated convolutions the weighting function of one timeseries becomes that of another, equation 1, where X is the timeseries and i the respective spectral channel. This results in a multiple filtering of the data and the effective reduction of wavelength variable systematic noise (Swain et al. 2010, Waldmann et al. submitted, Pagiatakis et al. 2007).

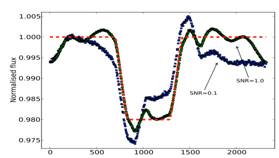
$$(X_i * X_{i+1})[n] := \sum_{t=1}^{n} X_i[t] X_{i+1}[n-t] \qquad (1)$$

For the ease of computation, this process can be redefined as the multiplication of timeseries sets in the frequency domain (equation 2).

$$f_\lambda(t) = \mathcal{F}^{-1}\left[\left(\prod_{i=1}^{m} \mathcal{F}[X_i(t)]\right)^{1/m}\right] \qquad (2)$$

We have tested this method for stability at extremely low signal to noise per spectral channel (SNR << 1.0) conditions using Monte Carlo simulations (Waldmann et al. submitted) and have found the retrieval of the eclipse's transit depth to be very stable down to a SNR of 0.4 per spectral channel, without further calibrations, and down to SNR ~ 0.2 with additional constraints on the system. Furthermore, there is a strong interaction effect between noise and the signal at these low values of SNR which can be modeled and accounted for in one's analysis.

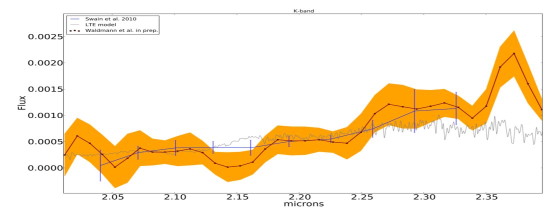


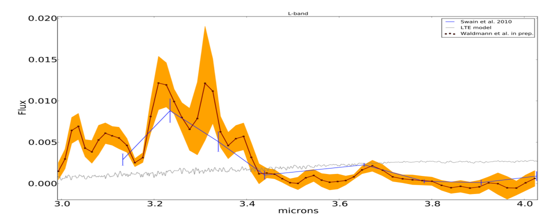


Left: Monte Carlo simulations showing the stability of the output transit-depth recovered (in percent of the input transit depth) for different lengths of out-of-transit data (OOT) and SNRs present. One can see the self-coherence method is very reliable for the SNR regime of > 0.4 per spectral channel. **Right:** Graph showing characteristic distortions of the lightcurve morphology to be expected for different SNRs (per spectral channel) present. The red curve is the input model and the blue and green curves are the self-coherence results for SNRs 0.1 and 1.0 respectively (Waldmann et al. submitted).

An example: HD189733b

We obtained data of a secondary eclipse of HD189733b on the 11th August 2007 in the K and L-bands using the IRTF/SpeX instrument. The observations followed the strategy outlined here, resulting in 470 spectra covering the eclipse feature (Swain et al. 2010). The data was reduced using the standard SpeX pipeline. Wavelength invariable noise present in the data, is reduced by normalising along the wavelength and time axes. The data is then passed to the self-coherence routine where the Fourier product is calculated for wavelength bins of 50 spectral channels. Using a moving block rather than stationary bins increases the sensitivity to sharp spectral features such as the non-LTE methane emission in the L-band spectrum. The high resolution analysis of the Swain et al. (2010) data is shown below.





Secondary eclipse emission spectra of HD 189733b taken with IRTF/SpeX. Blue points are by the Swain et al. (2010) and red points are by Waldmann et al. (in prep.) using a high-resolution analysis of the same data-set. The light-grey line shows the LTE model of the planet. **Top:** K-band showing good agreements between Swain et al. and Waldmann et al. **Bottom:** L-band emission spectrum showing the methane non-LTE emission feature between 3.2-3.4 microns in unprecedented detail.

Ingo Waldmann, ingo@star.ucl.ac.uk
University College London, Dept. Physics & Astronomy

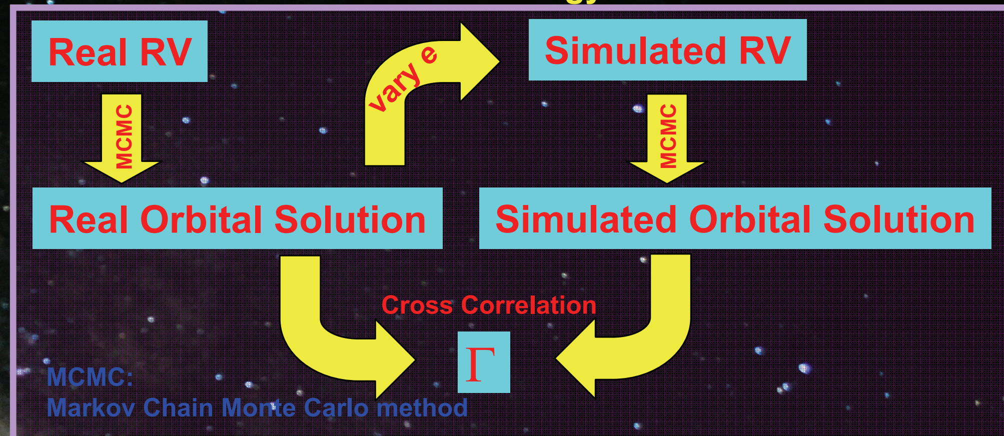
Eccentricity Distribution of Short-Period Exoplanets

Ji Wang, Eric B. Ford University of Florida

Introduction

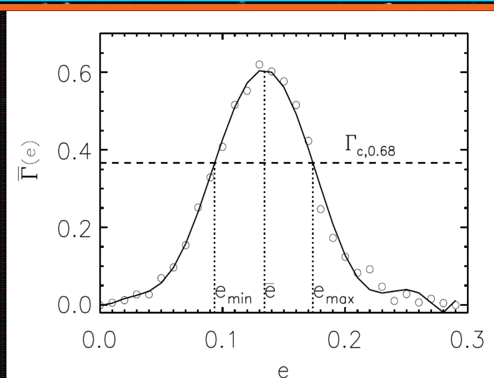
We apply standard MCMC analysis for 50 short-period, single-planet systems discovered with radial velocity technique. We develop a new method for accessing orbital eccentricity, namely Γ analysis, which combines frequentist bootstrap approach with Bayesian analysis of each simulated data set. We use a Bayesian population analysis to show that a mixture of analytical distributions is a good approximation of the underlying eccentricity distribution. For short-period planets, we find the most probable values of parameters in the analytical functions given the observed eccentricities. These analytical functions can be used in theoretical investigations or as priors for the eccentricity distribution when analyzing short-period planets. As the measurement precision improves and sample size increases, the method can be applied to more complex parametrizations for the underlying distribution of eccentricity for extrasolar planetary systems.

Methodology



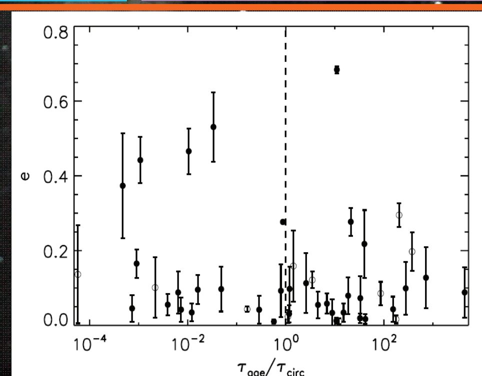
Result

a)



Example of HD 68988 b

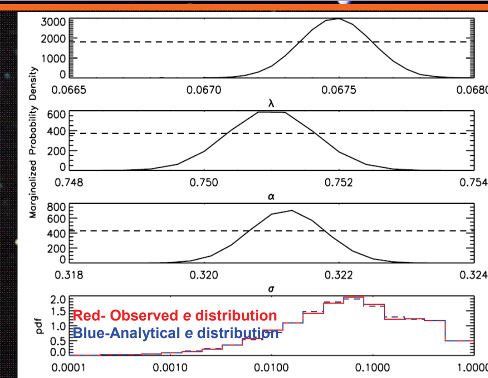
b)



Indication of Tidal Effect:

e - τ_{age} / τ_{circ} distribution

c)



Bayesian approach to underlying analytical e distribution for short-period exoplanet systems:

$$f(e|\alpha,\beta,\sigma)=\alpha\cdot f_{Exponential}(e|\beta)+(1-\alpha)\cdot f_{Rayleigh}(e|\sigma)$$

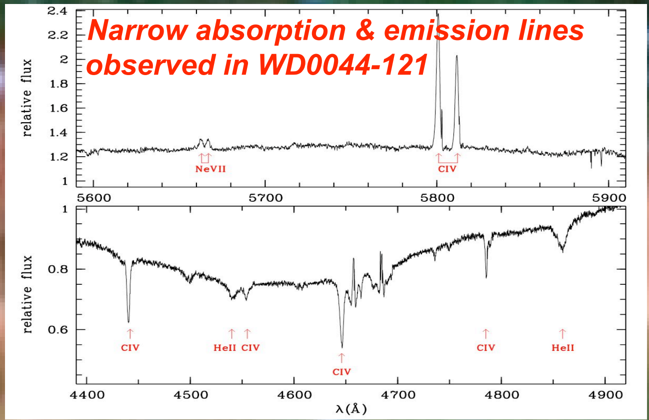
A Substellar companion around a hot pre-white dwarf WD 0044-121

W. Wang[1], J. Setiawan[1], Th.Henning[1], K. Werner[2], Th. Rauch[2], S. Dreizler[3], U. Seemann[3]

1) 1) Max-Planck-Insitute for Astronomy, Heidelberg, Germany; 2) Institute for Astronomy and Astrophysics, Tubingen, Germany

3) Institute for Astrophysics, Gottingen, Germany; 4) European Southern Observatory, Garching, Germany

Abstract: Efforts have been devoted to the researches on the evolution of planetary systems, which is of strong astrophysical interests. One challenging question is whether planets could survive the final phase of stellar evolution. To explore this issue, we began a pilot survey for close substellar companions around nearby bright white dwarfs with the radial-velocity (RV) technique using FEROS at 2.2 m MPG/ESO telescope. From our survey, a RV variation with period of 4.1d and amplitude of ~2km/s was detected in WD0044-121.We ruled out stellar rotation, pulsations or stellar winds as possible causes for this variation. We argued that it should be caused by a companion with Msini~9.37M_{Jup} and a~0.05AU. This suggests that giant planets/brown dwarfs may survive the final evolutionary stages.

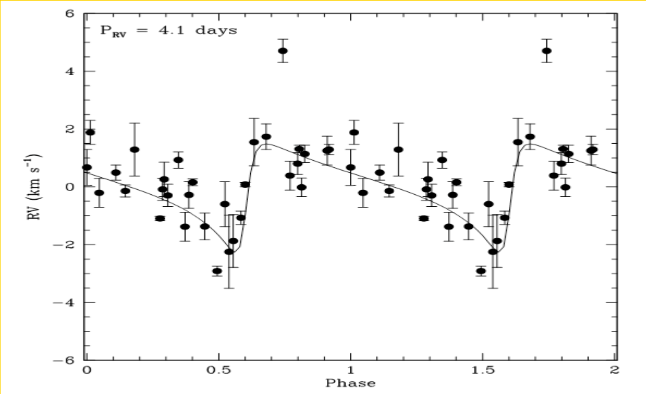


WD0044-121

a pre-WD or PG1159 star, the CS of PN NGC 246

Stellar parameters of WD 0044-121.

Parameters	Value	Unit	Reference
Spectral Type	Op		SIMBAD
m_V	11.77	mag	*Hipparcos*
distance	629	pc	*Hipparcos*
T_{eff}	150 000	K	Koesterke & Werner (1998)
log g	5.7		Koesterke & Werner (1998)
m	0.75	$M_\odot$	Miller Bertolami & Althaus (2006)
log L	4.2	$L_\odot$	Koesterke & Werner (1998)
R	22	R.	this work
Pulsations periods	~30	mins	González Pérez et al. (2006)



Orbital parameters of WD 0044-121b.

P	4.1 ±0.1	days
K_1	1.928±0.1	km s^{-1}
e	0.67 ±0.05	
m_2 $sini$	9.37±0.7	M_{Jup}
a	0.046±0.001	AU

Conclusions

1) First close substellar companion to a hot WD

2) e = 0.67, excited by Kozai mechanism or mass loss

3) the host star was the most massive one

4) 'oasis in the desert' of close planets around stars with M>1.5M_{sun}

Email: wwang@mpia.de

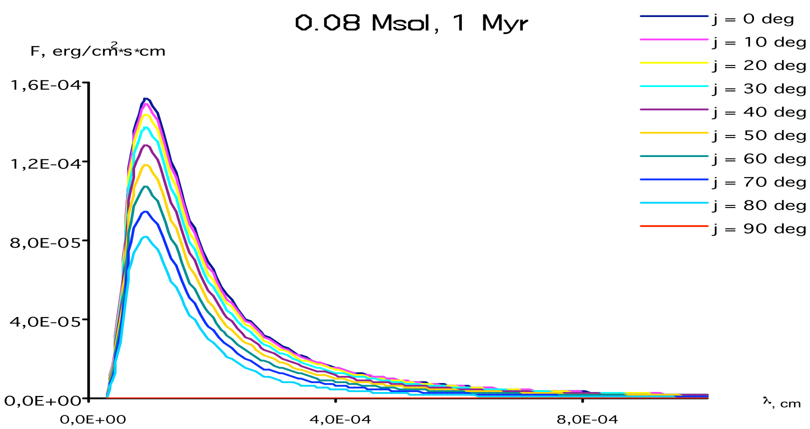
SEDs of circumsubstellar disks versus their age and spatial location

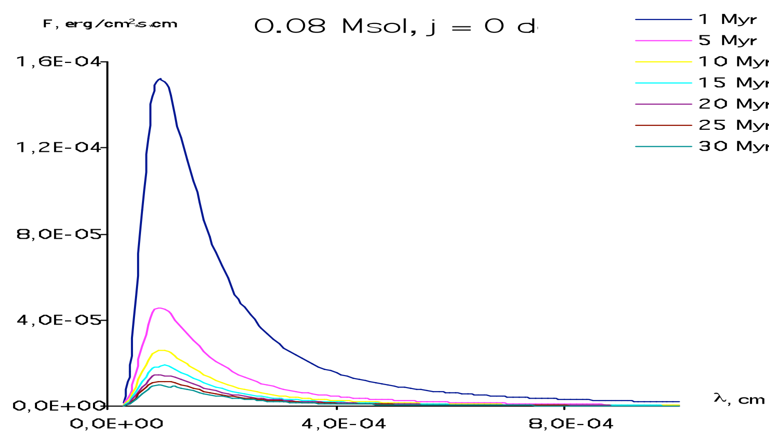
Zakhozhay Olga

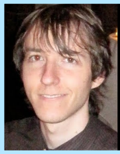
Main Astronomical Observatory NAS of Ukraine

- **The aim** of this work is to make a SEDs simulations of the circumsubstellar disks based on the existing evolutionary model (Pisarenko et al. 2007) of substellar objects (0.08-0.01M_{sun}).

- The SEDs simulations were made for systems that are
  - in the ages from 1 to 30 Myr;
  - located in different angles inclination toward observer;
  - substars and protoplanetary disks radiate like “black body”;
  - distance from Sun to substar equals to 10 pc.



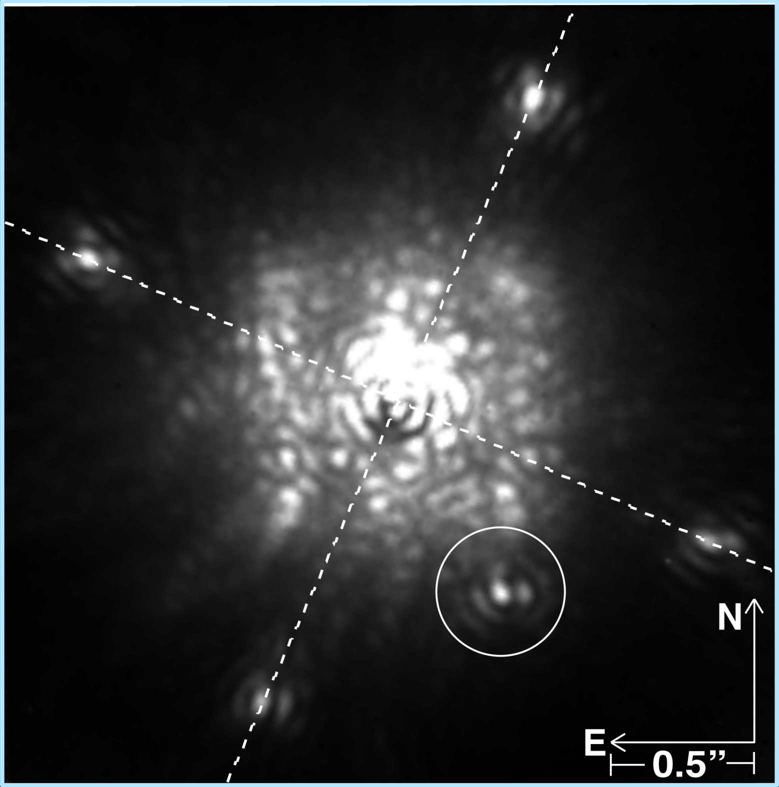




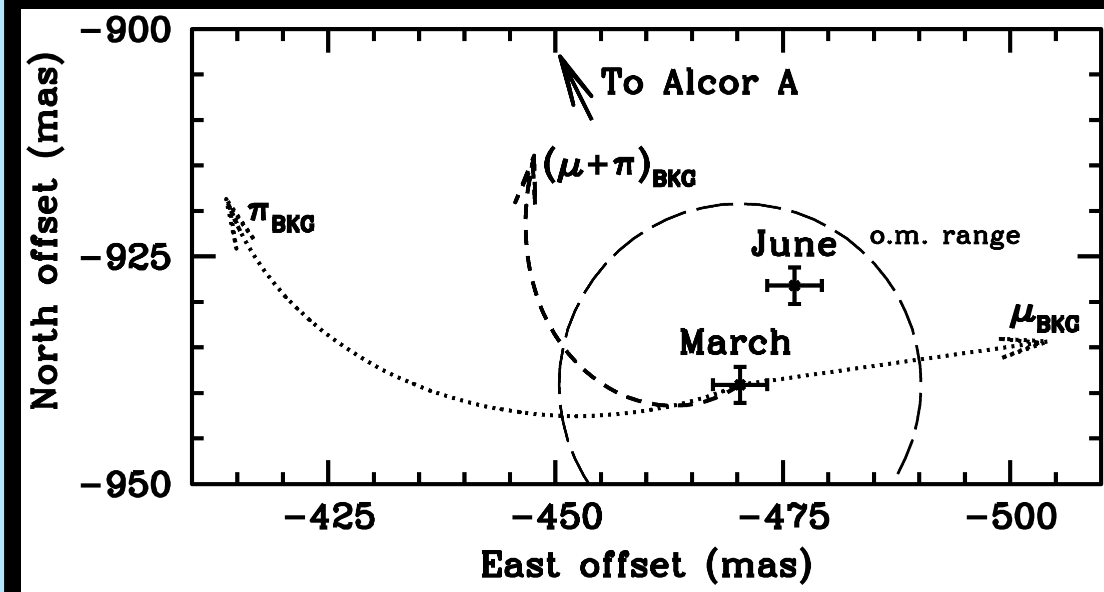
Neil Zimmerman
Columbia/AMNH

High Contrast Studies of Nearby Stars with Project 1640

with Ben R. Oppenheimer (P.I.), Sasha Hinkley, Anand Sivaramakrishnan, Ian Parry, Doug Brenner



Alcor and M-dwarf companion



Relative astrometry over 3 months, confirming physical association