The discovery of the First Eclipsing White Dwarf Binary System

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2010/5/25

NLTT 11748

- Low mass (~0.167 ± 0.005 solar mass) helium core white dwarf
- T_{eff}=8540±50 K
- H rich atmosphere

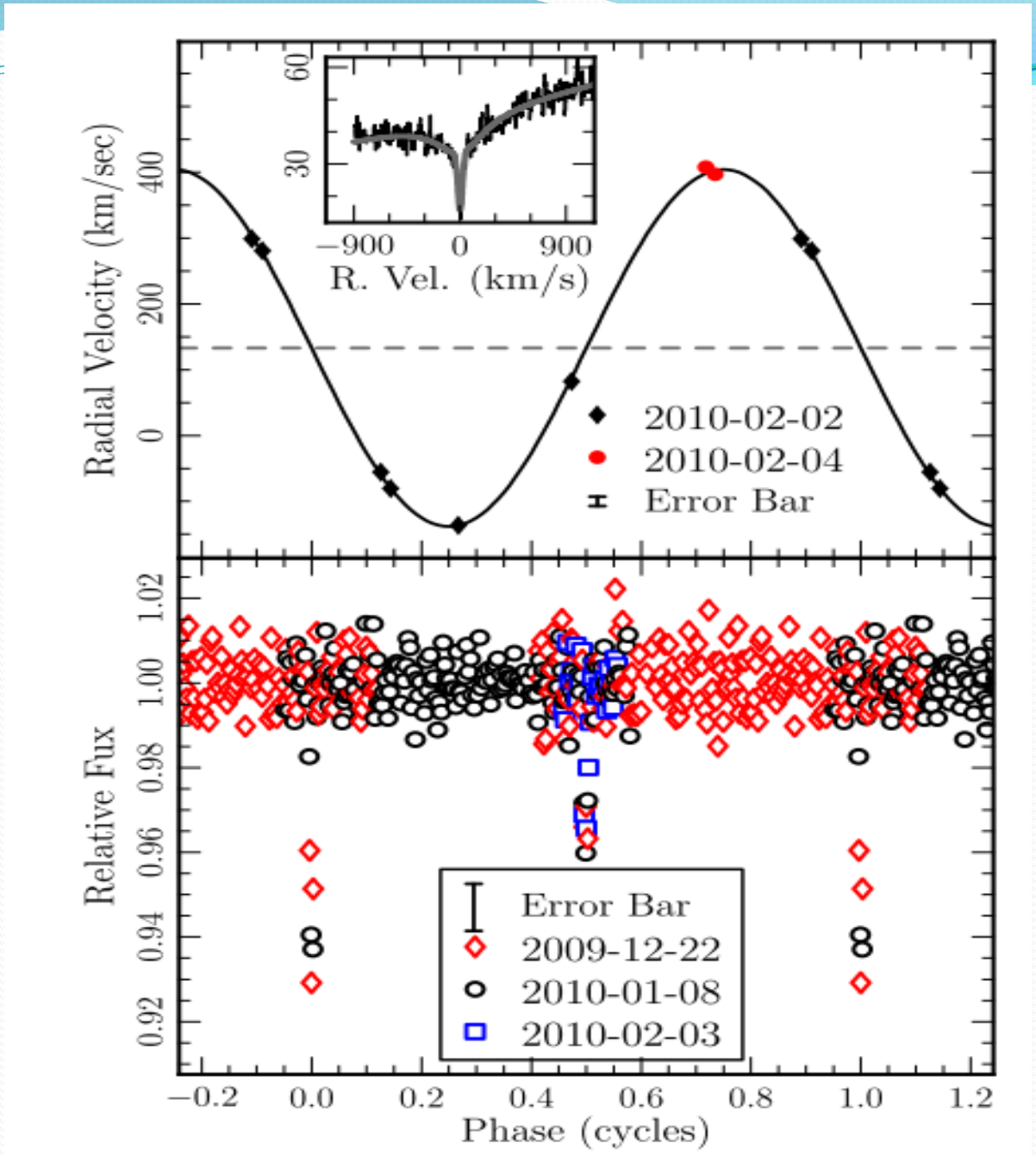
  (Kawka &Vennes 2009 A&A)
- Theoretical works on the low mass He-core WD suggest that the WDs undergo stable H burning for Gyrs, slowing their evolution and keeping brighter for much longer than expected.
- The size of this kind of WD had never been measured.

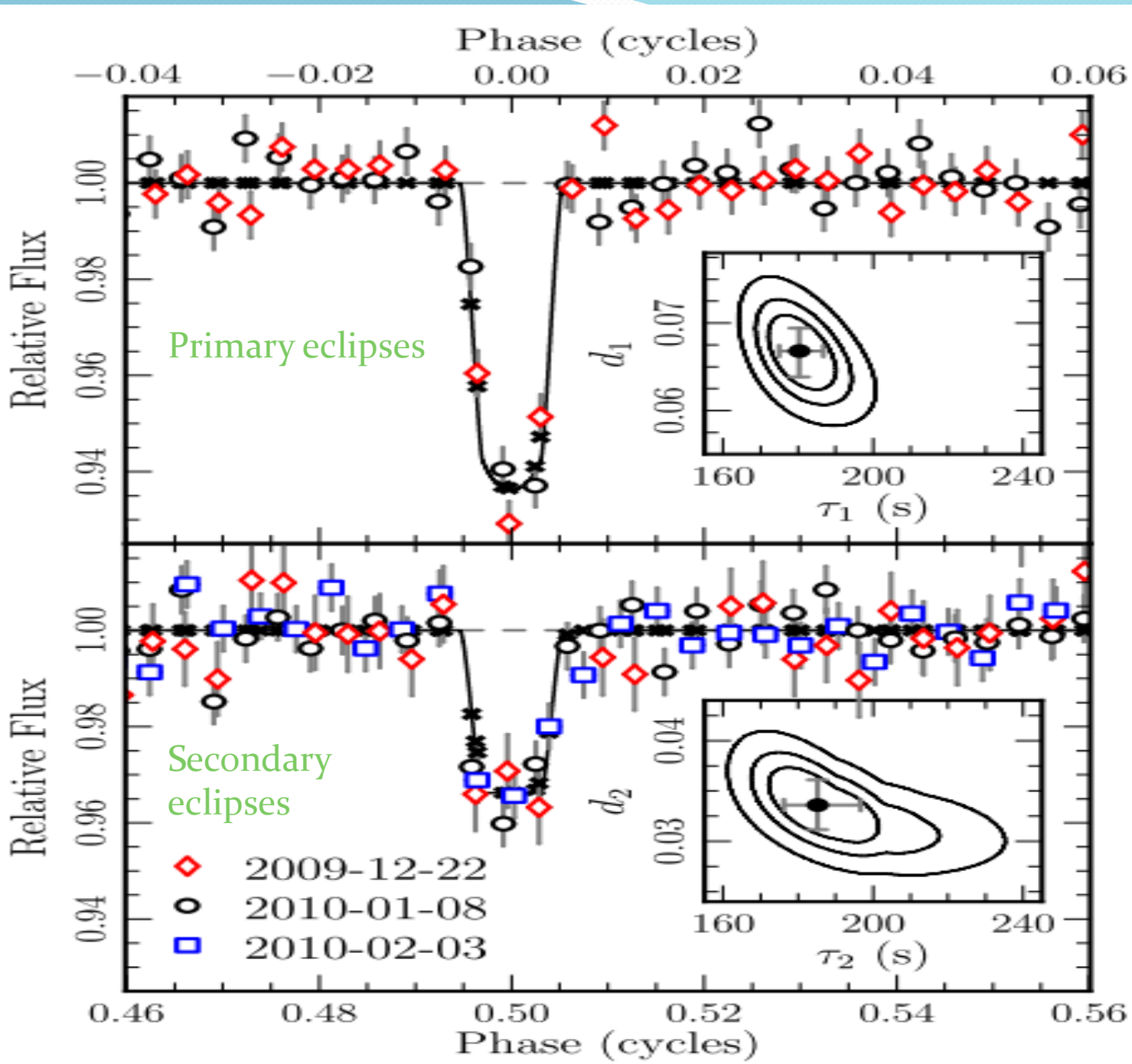
News

- P_{orb}~5.6 hrs
- 180-sec 3-6% dips in the photometry is discovered by Faulkes Telescope North of the Las Cumbres Observatory Global Telescope.
- Radial velocity is measured by Keck telescope:

  $v_r = 133 \pm 2$ km/s

  $K_1 = 271 \pm 3$ km/s


Radial Velocity (km/sec)
400
200
0
60
30
−900
0
900
R. Vel. (km/s)
2010-02-02
2010-02-04
Error Bar
Relative Fux
1.02
1.00
0.98
0.96
0.94
0.92
Error Bar
2009-12-22
2010-01-08
2010-02-03
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Phase (cycles)


Phase (cycles)
−0.04
−0.02
0.00
0.02
0.04
0.06
Relative Flux
1.00
0.98
0.96
0.94
Primary eclipses
d_1
0.07
0.06
160
200
240
τ_1 (s)
Secondary eclipses
d_2
0.04
0.03
τ_2 (s)
2009-12-22
2010-01-08
2010-02-03
0.46
0.48
0.50
0.52
0.54
0.56
Phase (cycles)

News

- There are 6 relevant binary parameters to be fitted:

  masses: M_1, M_2

  radii:R_1, R_2

  flux ratio: F_1/F_2

  inclination: i
- The limb darkening coefficient and the orbital period are fixed in the fitting.
- The microlensing effect is included in the fitting.

Quantity	Value		
HIRES spectra:			
Rad. Vel. Amp. K_1 (km s^{-1}) ..	271(3)		
Sys. Radial Velocity (km s^{-1}) .	133(2)		
χ^2/DOF	4.5/6		
FTN photometry:			
Time of Prim. Ecl. (BJD TDB)	2,455,196.87828(7)		
Period (days)	0.2350606(11)		
Ephemeris χ^2/DOF	3.5/3		
Primary Eclipse Depth d_1	0.067(3)		
Secondary Eclipse Depth d_2 ..	0.034(2)		
Primary Ecl. Duration τ_1 (s) ..	180(6)		
Secondary Ecl. Duration τ_2 (s)	185(10)		
F_2/F_1 (in SDSS-g′)	0.035(3)		
Out of Eclipse[a] χ^2/DOF	404.8/372		
Combined data (assuming Mass of Primary $M_1 = 0.15 M_\odot$):			
Limb Darkening Coeff. u_{LD} ..	0.0	0.3	0.5
Mass of Secondary M_2 ($M_\odot$) .	0.71(2)	0.71(2)	0.71(2)
Inclination (deg)	89.90(11)	89.88(11)	89.87(11)
Radius of Primary R_1 ($R_\odot$) ...	0.0393(9)	0.0406(9)	0.0415(9)
χ^2/DOF[b]	285.1/227	279.5/227	276.5/227
Distance[c] (pc)	150(32)		
Sys. Kin. (U, V, W)[d] (km s^{-1}) .	(-151(9), -183(41), -34(5))		

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- i ~ 90 °
- R2/R1 ~1/4 derived from eclipse depths
- T2 ≦ 7400 K
- M2=0.648-0.771 solar mass for M1=0.1-0.2 solar mass

→ The secondary WD should be a faint C/O WD

- R1=0.043-0.039 solar radius for M1=0.1-0.2 solar mass
- The observations of the star NLTT 11748 have made the first direct radius measurement and the radius value is consistent with the theoretically expected values for a He-core WD with thick, stably burning hydrogen envelope.

References

- Astrophysicists discover unique eclipsing binary star system(http://www.astronomy.com/asy/default.aspx?c=a&id=9870)
- Unique Eclipsing Binary Star System Discovered (http://www.sciencedaily.com/releases/2010/05/100519092704.htm)
- Discovery of the Eclipsing Detached Double White Dwarf Binary NLTT 11748

  Justin D. R. Steinfadt et al.

  arXiv:1005.1977[astro-ph.SR]

>>Thank You<<