

## Atividades desenvolvidas em 2011-2012

Leonardo Andrade de Almeida

Orientador: Francisco Jablonski,  
Colaboradores: Claudia V. Rodrigues,  
Julio Tello,  
Marildo G. Pereira.

Divisão de Astrofísica  
Instituto Nacional de Pesquisas Espaciais

20 de março de 2012

O Sistema Triplo LHS 1070

Buscando por Exoplanetas ao Redor de Sistemas Binários  
Eclipsantes e Sistemas Planetários com Trânsitos

Caracterização de Sistemas Binários Eclipsantes do tipo HW Vir

Campanha Observacional de Microlentes Gravitacionais ( $\mu$ -Fun)

Tese, Co-orientações e Sumário

# Sumário

## O Sistema Triplo LHS 1070

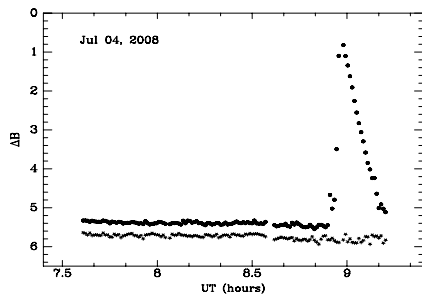
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# O Flare



Flare observado em Julho de 2008 no sistema LHS 1070

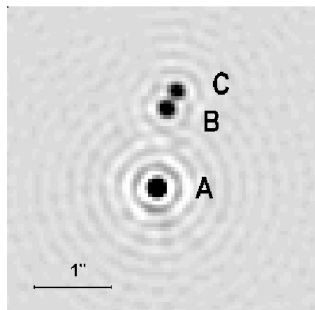


Imagem do sistema LHS 1070 obtida em 1993 por Leinert et al. (1994)

# O Flare

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Astronomy  
&  
Astrophysics

## Identification of strong photometric activity in the components of LHS 1070

L. A. Almeida, F. Jablonski, and E. Martioli

Instituto Nacional de Pesquisas Espaciais/MCT, Avenida dos Astronautas 1758, São José dos Campos, SP, 12227-010, Brazil  
e-mail: Leonardo@das.inpe.br

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### ABSTRACT

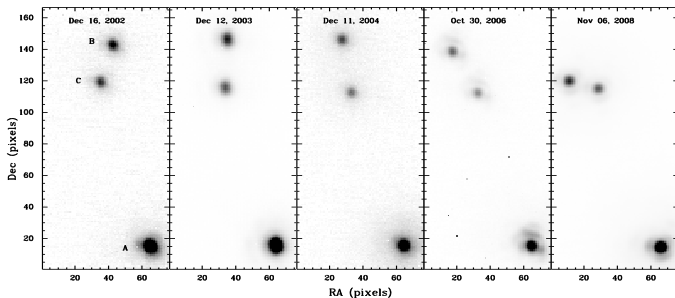
**Context.** Activity in low-mass stars is an important ingredient in their evolution. Fundamental physical properties such as age, rotation, and magnetic field are correlated with activity.

**Aims.** We show that two components of the low-mass triple system LHS 1070 exhibit strong flaring activity. We identify the flaring components and obtained an improved astrometric solution for the LHS 1070  $\mathcal{A}/(B+C)$  system.

**Methods.** Time-series CCD observations were used to monitor LHS 1070 in the  $B$  and  $I_c$  bands.  $H$ -band data were used to obtain accurate astrometry for the LHS 1070  $\mathcal{A}/(B+C)$  system.

**Results.** We find that two components of the triple system LHS 1070 exhibit photometric activity. We identified components  $\mathcal{A}$  and  $B$  as the flaring objects. We estimate the total energy,  $\sim 2.0 \times 10^{33}$  erg, and the magnetic field strength,  $\sim 5.5$  kG, of the flare observed in LHS 1070  $B$ . This event has one of the largest amplitudes,  $\Delta B \gtrsim 8.2$  mag, ever observed in a flare star.

# Determinação das Massas Individuais no Sistema LHS 1070



Sequência de imagens de LHS 1070 obtidas com o instrumento NACO/VLT.

# Solução orbital para a binária LHS 1070 B/C

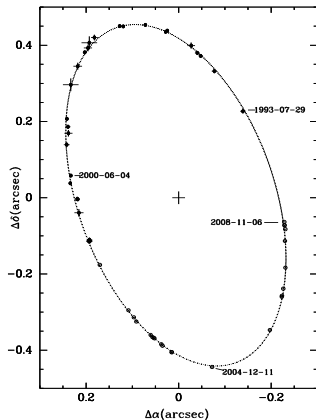
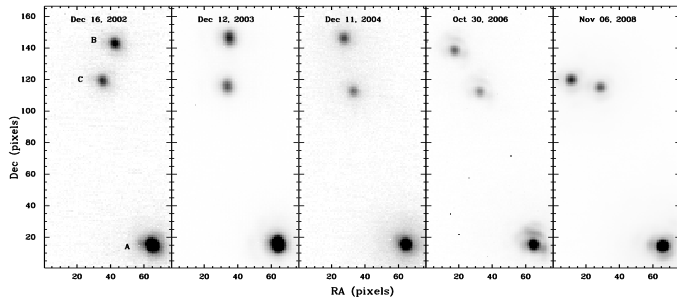


Tabela: Solução orbital

Parameter	Value
$P$ (yr)	$17.1877 \pm 0.0009$
$T_0$ (yr)	$1990.481 \pm 0.002$
$\alpha_{BC}$ (")	$0.4590 \pm 0.0005$
$a$ (AU)	$3.5373 \pm 0.0008$
$e$	$0.026 \pm 0.002$
$i$ ( $^\circ$ )	$61.98 \pm 0.11$
$\Omega$ ( $^\circ$ )	$14.36 \pm 0.08$
$\omega$ ( $^\circ$ )	$229.0 \pm 0.5$
$\chi_{\text{red}}^2$	2.6
$^1M_{\text{LHS 1070 B/C}}$ ( $M_\odot$ )	$0.1493 \pm 0.006$

<sup>1</sup> Usando a distância de  $7.72 \pm 0.15$  pc Costa et al. (2005)

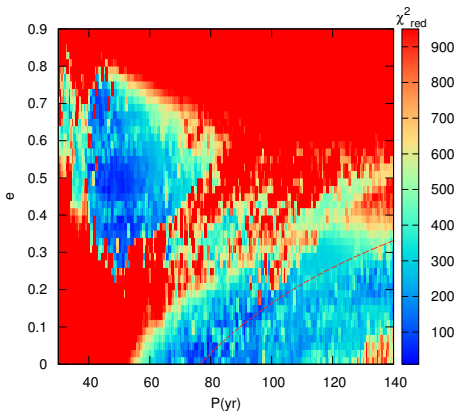
# Determinação das Massas Individuais no Sistema Triplo LHS 1070



Sequência de imagens de LHS 1070 obtidas com o instrumento NACO/VLT.

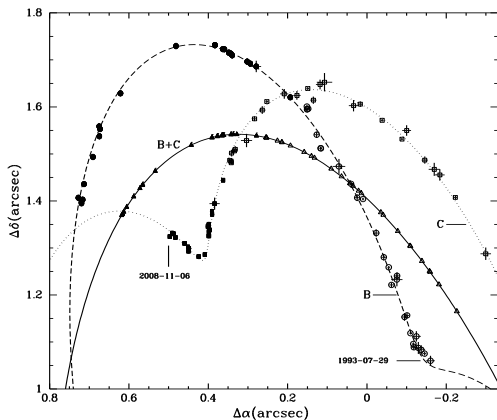


# Determinação das Massas Individuais no Sistema LHS 1070



Sequência de imagens de LHS 1070 obtidas com o instrumento NACO/VLT.

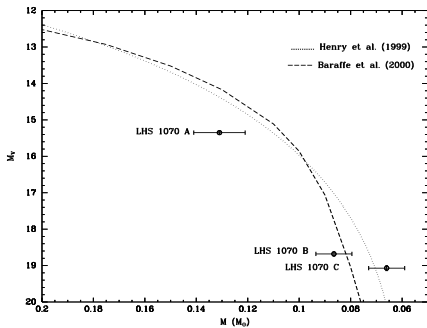
# Solução orbital para a binária LHS 1070 A/B+C



Parameter	Value
$P$ (yr)	$84.54 \pm 3.6$
$T_0$ (yr)	$1998.5 \pm 2.8$
$\alpha_{A/(B+C)}$ (")	$1.64 \pm 0.05$
$\alpha_{(B+C)-B}$ (")	$0.440 \pm 0.002$
$\alpha_{(B+C)-C}$ (")	$0.481 \pm 0.002$
$e$	$0.06 \pm 0.03$
$i$ ( $^\circ$ )	$64.2 \pm 0.8$
$\Omega$ ( $^\circ$ )	$14.4 \pm 0.6$
$\omega$ ( $^\circ$ )	$335.0 \pm 4.0$
${}^1M_{\text{LHS 1070 B}}$ ( $M_\odot$ )	$0.085 \pm 0.007$
${}^1M_{\text{LHS 1070 C}}$ ( $M_\odot$ )	$0.066 \pm 0.007$
${}^1M_{\text{LHS 1070 ABC}}$ ( $M_\odot$ )	$0.281 \pm 0.01$

<sup>1</sup> Usando a distância de  $7.72 \pm 0.15$  pc

# Determinação das Massas Individuais no Sistema LHS 1070



# Sumário

O Sistema Triplo LHS 1070

Buscando por Exoplanetas ao Redor de Sistemas Binários Eclipsantes e Sistemas Planetários com Trânsitos

Caracterização de Sistemas Binários Eclipsantes do tipo HW Vir

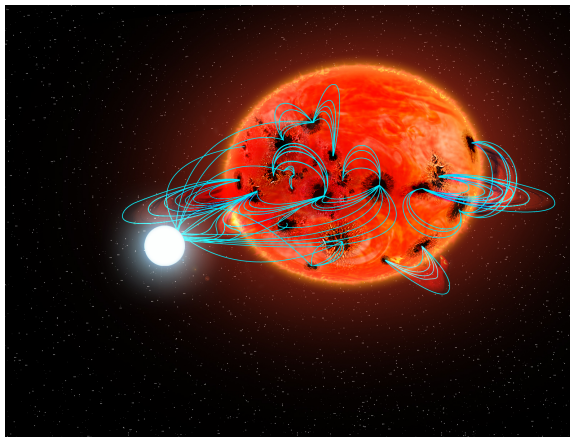
Campanha Observacional de Microlentes Gravitacionais ( $\mu$ -Fun)

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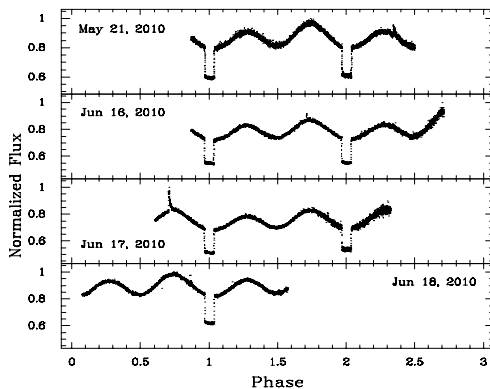
## Alvos

- Sistemas binários cerrados (anã branca + anã vermelha);
- QS Vir; SDSS 0110+1326; NN Ser; SDSS 0303+0054 e GK Vir;
- Sistemas binários cerrados (sub-anã do tipo B + anã vermelha);
- HW Vir; NSVS 14256825; HS 2234+2444 e Bul SC 16335;
- Sistemas Planetários com trânsitos ( $P_{\text{orb}} < 10$  dias);
- Wasp-2b; Wasp-4b; Wasp-5b; Wasp-46b; CoRoT-2b; CoRoT 11b.

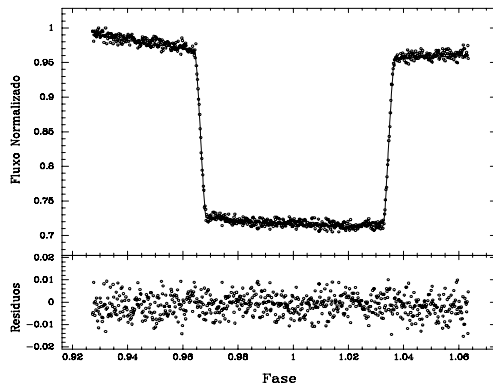
## QS Vir - Conceção artística



## QS Vir - Curvas de luz do sistema



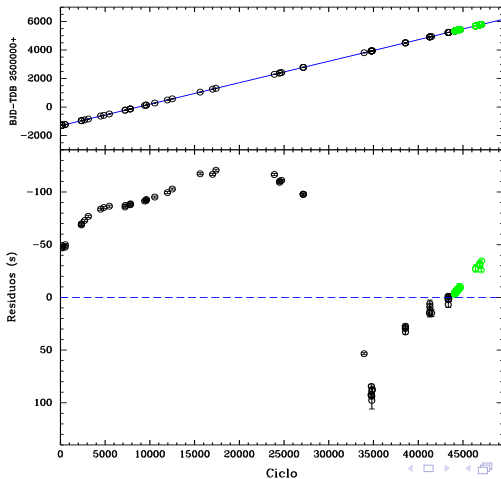
## QS Vir - Ajuste do eclipse





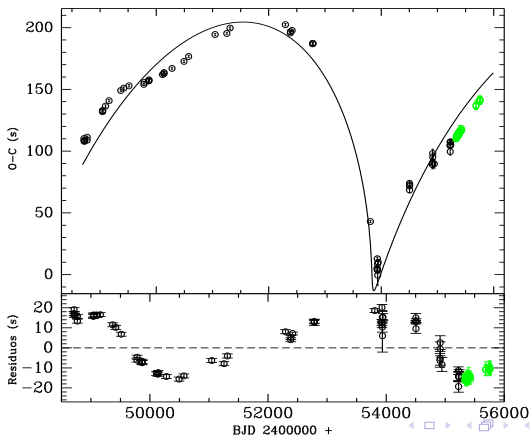
## QS Vir - Ajuste linear

$$T_{\min} = T_0 + E \times P_{\text{orb}}$$



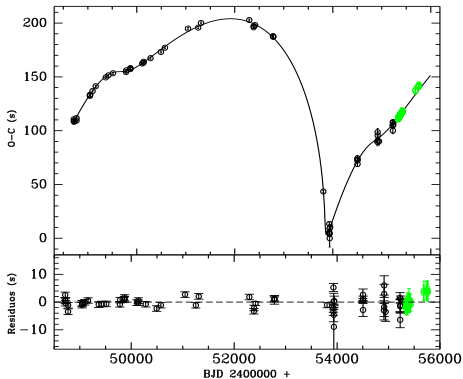
## QS Vir - Um corpo externo

$$T_{\min} = T_0 + E \times P_{\text{orb}} + \tau_1$$



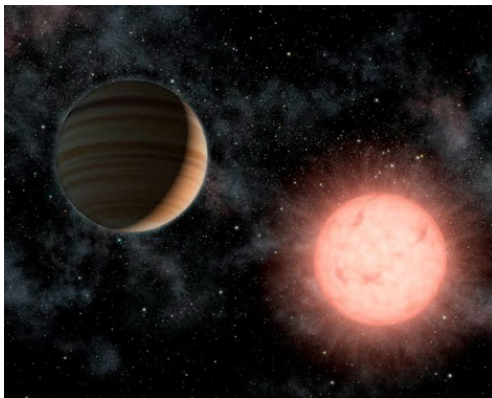
## QS Vir - Dois corpos externos

$$T_{\min} = T_0 + E \times P_{\text{orb}} + \tau_1 + \tau_2$$



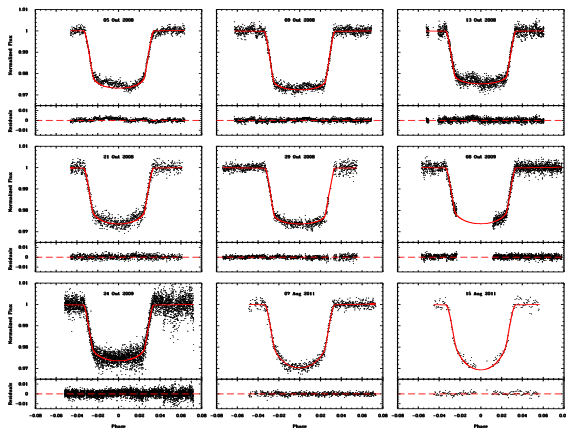
## Wasp-4b - Concepção Artística

Wilson et al (2008);  $0.97 M_{\odot}$ ;  $1.22 M_{\text{Jup}}$ ; 1.33 dias.

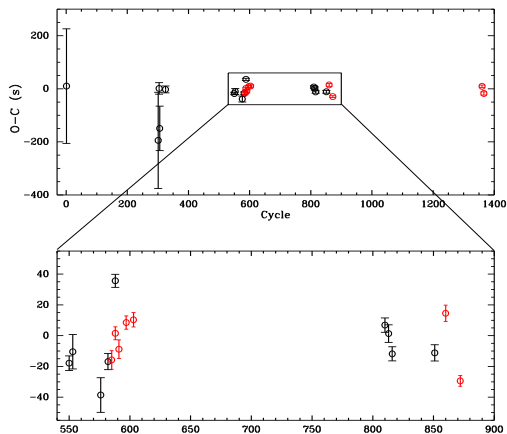


Fonte: <http://www.popularmechanics.com/science/space/deep/4335269>

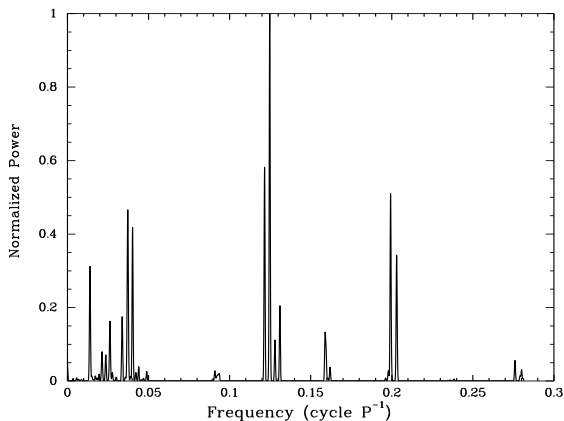
# Wasp-4b - Trânsitos



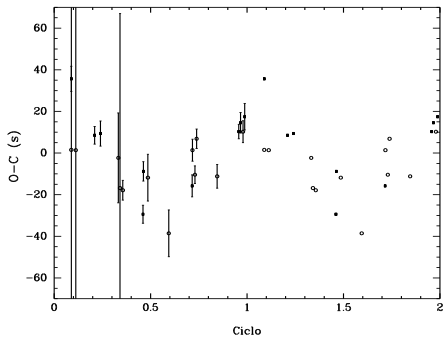
## Wasp-4b - Diagrama (O-C)



# Wasp-4b - Periodograma



# Wasp-4b - Diagrama de Fase





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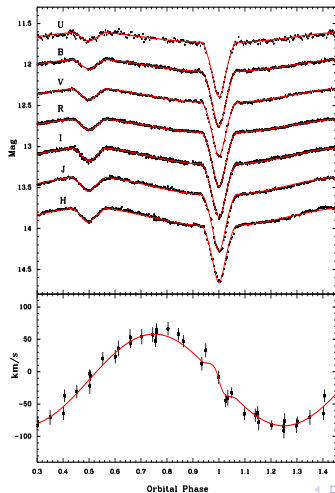
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# NSVS 14256825 - Segundo sistema descoberto do tipo sdOB + dM eclipsante



# NSVS 14256825 - Segundo sistema descoberto do tipo sdOB + dM eclipsante



# NSVS 14256825 - Segundo sistema descoberto do tipo sdOB + dM eclipsante

## A photometric and spectroscopic study of NSVS 14256825: the second sdOB+dM eclipsing binary\*

L. A. Almeida<sup>‡</sup>, F. Jablonski, J. Tello and C. V. Rodrigues

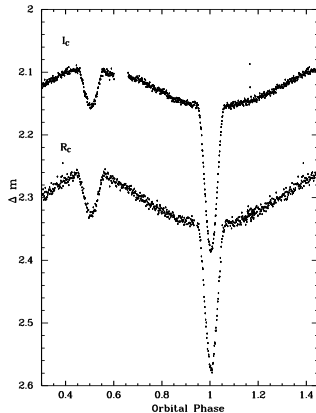
*Instituto Nacional de Pesquisas Espaciais/MCTI, Av. dos Astronautas 1758, São José dos Campos, SP, 12227-010, Brazil*

Released 2002 Xxxxx XX

### ABSTRACT

We present an analysis of UBVR<sub>c</sub>LCJH photometry and phase-resolved optical spectroscopy of NSVS 14256825, an HW Vir type binary. The members of this class consist of a hot subdwarf and a main-sequence low-mass star in a close orbit ( $P_{orb} \sim 0.1$  d). Using the primary-eclipse timings, we refine the ephemeris for the system, which has an orbital period of 0.11037 d. From the spectroscopic data analysis, we derive the effective temperature,  $T_1 = 4000 \pm 500$  K, the surface gravity,  $\log g_1 = 5.50 \pm 0.05$ , and the helium abundance,  $n(\text{He})/n(\text{H}) = 0.003 \pm 0.001$ , for the hot component. Modelling simultaneously the photometric and spectroscopic data with the Wilson-Devinney code, we obtained the geometrical and physical parameters of NSVS 14256825. With an orbital inclination,  $i = 82.5 \pm 0.3$ , and mass ratio,  $q = M_2/M_1 = 0.260 \pm 0.012$ , the components of the system have  $M_1 = 0.419 \pm 0.070 M_{\odot}$ ,  $R_1 = 0.188 \pm 0.010 R_{\odot}$ ,  $M_2 = 0.109 \pm 0.023 M_{\odot}$ , and  $R_2 = 0.162 \pm 0.008 R_{\odot}$ . From its spectral characteristics, the hot star is classified as a sdOB star.

## HS2231+2441



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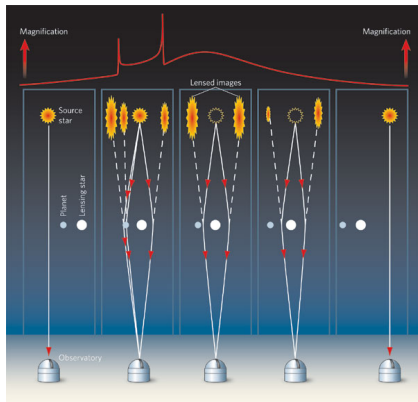
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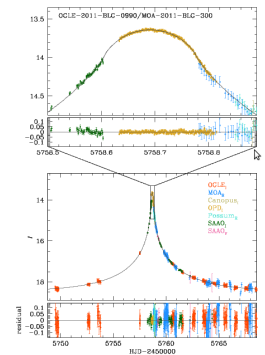
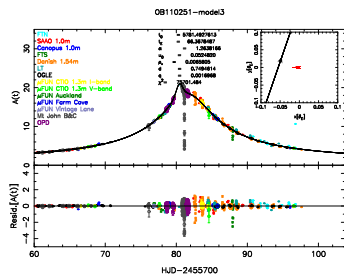
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## Concepção Artística



Fonte: <http://www.nature.com/nature/journal/v439/n7075/figtab/439400aF2.html>

## Alvos observados com o OPD



Choi et al. (2011)



## Participação em Artigos

MOA 2010-BLG-477Lb: constraining the mass of a microlensing planet from microlensing parallax, orbital motion and detection of blended light

E. Bacheler<sup>1</sup>, I.-G. Shim<sup>2</sup>, C. Han<sup>3,4</sup>, P. Fouquet<sup>5</sup>, A. Gould<sup>6</sup>, J.W. Menzies<sup>5</sup>, J.-P. Beaulieu<sup>6</sup>, D.P. Bennett<sup>1,4</sup>, I.A. Bond<sup>6</sup>, S. Dong<sup>6,14</sup>, D. Heyrovský<sup>7</sup>, J.-B. Marquette<sup>8</sup>, J. Mashhal<sup>4</sup>, J. Shown<sup>9</sup>, R.A. Street<sup>10</sup>, T. Sumi<sup>13,4</sup>, A. Udalski<sup>16</sup>,

and

Ā. Abe<sup>20</sup>, K. Agabi<sup>20</sup>, M.D. Albrow<sup>12</sup>, W. Allen<sup>20</sup>, E. Bertin<sup>20</sup>, M. Bos<sup>11</sup>, D.M. Bramich<sup>17</sup>, J. Claverie<sup>26</sup>, G.W. Christie<sup>20</sup>, A.A. Cole<sup>20</sup>, N. Couznet<sup>20</sup>, S. Dieter<sup>20</sup>, M. Dominik<sup>20,60</sup>, J. Drummond<sup>17</sup>, J. Greenhill<sup>20</sup>, T. Guillot<sup>19</sup>, C.B. Heald<sup>14</sup>, F.V. Hessman<sup>14</sup>, K. Horro<sup>20</sup>, M. Houndtman<sup>15,59</sup>, J. Johnson<sup>6</sup>, U.G. Jørgensen<sup>20,15</sup>, R. Kanier<sup>20</sup>, C. Lidtke<sup>20,17</sup>, D. Mihara<sup>20</sup>, J. McCorrick<sup>20</sup>, D. Moór<sup>18,54</sup>, T. Nagayama<sup>19</sup>, D. Nataf<sup>1</sup>, T. Natsume<sup>20,17</sup>, S. Nishiyama<sup>41</sup>, J.-P. Rivas<sup>21</sup>, K.C. Sahai<sup>21</sup>, Y. Shvartzvald<sup>15</sup>, G. Thone<sup>14</sup>, A.R. Tomczak<sup>14</sup>, Y. Tsapras<sup>6,35</sup>, J.C. Yee<sup>1</sup>,

and

V. Batista<sup>3,20</sup>, C.S. Bennett<sup>30</sup>, S. Brillant<sup>15</sup>, J.A.R. Caldwell<sup>16</sup>, A. Cassan<sup>1</sup>, E. Corrales<sup>30</sup>, C. Couturas<sup>30</sup>, D. Dominik Prester<sup>30</sup>, J. Domoszlów<sup>30</sup>, D. Kubas<sup>38,39</sup>, R. Martin<sup>30</sup>, A. Williams<sup>30</sup>, M. Zib<sup>37</sup>

(THE PLANET Collaboration),

D.L. DePoy<sup>30</sup>, B.S. Gaudi<sup>1</sup>, L.-W. Hung<sup>1</sup>, C.-U. Lee<sup>30</sup>, Y. Lee<sup>30</sup>, J.R. Koo<sup>30</sup>, R.W. Pogge<sup>1</sup>, S. Koo<sup>40</sup>, N. Klein<sup>40</sup>, D. Mac<sup>40</sup>, D. Pálfi<sup>40,41</sup>, J.A. Muna<sup>40</sup>, L. Andrade de Almeida<sup>40</sup>, F. Jędrak<sup>40</sup>

## MOA-2011-BLG-293Lb: A testbed for pure survey microlensing planet detection

J.C. Yee<sup>32</sup>, Y. Shvartzvald<sup>15</sup>, A. Gal-Yam<sup>14</sup>, I.A. Bond<sup>14</sup>, A. Udalski<sup>16</sup>, S. Kozłowski<sup>17,4</sup>, C. Han<sup>13</sup>, A. Gould<sup>12</sup>, J. Shown<sup>13,2</sup>, D. Suzuki<sup>13,10</sup>,

and

F. Abe<sup>12</sup>, D.P. Bennett<sup>12</sup>, C.S. Batista<sup>12</sup>, P. Chaz<sup>14</sup>, M. Freeman<sup>14</sup>, A. Fukui<sup>12</sup>, K. Furusawa<sup>12</sup>, Y. Ito<sup>12</sup>, S. Kobayashi<sup>12</sup>, C.H. Ling<sup>12</sup>, K. Masuda<sup>12</sup>, Y. Matsumoto<sup>12</sup>, M. Miyake<sup>12</sup>, Y. Mizuki<sup>12</sup>, K. Ohmer<sup>12</sup>, K. Okada<sup>12</sup>, N.J. Ratzenburg<sup>12</sup>, T. Sato<sup>12</sup>, D.J. Sullivan<sup>12</sup>, T. Sumi<sup>12</sup>, K. Suzuki<sup>12</sup>, W.I. Swatnam<sup>12</sup>, S. Takino<sup>12</sup>, P.J. Tristram<sup>12</sup>, K. Wada<sup>12</sup>, P.C.M. Yock<sup>12</sup>

(the MOA Collaboration),

M.K. Szymanski<sup>16</sup>, M. Kubak<sup>16</sup>, G. Pietrzyński<sup>16,1</sup>, I. Soszyński<sup>16</sup>, R. Poleski<sup>16</sup>, K. Ulaczyk<sup>16</sup>, L. Wyrzykowski<sup>16,21</sup>, P. Pietrukiewicz<sup>16</sup>

(the OGLE Collaboration),

W. Allen<sup>18</sup>, L. A. Almeida<sup>18</sup>, V. Batista<sup>18</sup>, M. Bos<sup>18</sup>, G. Christie<sup>18</sup>, D.L. DePoy<sup>18</sup>, Subo Dang<sup>18</sup>, J. Drummond<sup>18</sup>, I. Finkbeiner<sup>18</sup>, B.S. Gaudi<sup>18</sup>, E. Geisler<sup>18</sup>, C. Heald<sup>18</sup>, D. Hogg<sup>18,19</sup>, F. Jędrak<sup>18</sup>, S. Koo<sup>18</sup>, J. Masada<sup>18</sup>, D. Mao<sup>18</sup>, J. McCorrick<sup>18</sup>, D. McGregor<sup>18</sup>, L.A.G. Monari<sup>18</sup>, D. Moór<sup>18</sup>, J.A. Muna<sup>18</sup>, T. Nataf<sup>18,19</sup>, H. Naga<sup>18</sup>, E. Olsz<sup>18</sup>, R.W. Pogge<sup>18</sup>, R. Szostak<sup>18</sup>, T.-G. Tan<sup>18</sup>, G. Thone<sup>18</sup>,

and

I.-G. Shim<sup>18</sup>, J.-Y. Choi<sup>18</sup>, S.-Y. Park<sup>18</sup>, C.-U. Lee<sup>18</sup>, J.-H. Koo<sup>18</sup>

(the  $\mu$ FUN Collaboration)

[astro-ph.EP] 4 Jun 2012

## CHARACTERIZING LENSES AND LENSED STARS OF HIGH MAGNIFICATION GRAVITATIONAL MICROLENSING EVENTS WITH LENSES PASSING OVER SOURCE STARS

J.-Y. Choi<sup>1</sup>, I.-G. Shim<sup>2</sup>, S.-Y. Park<sup>3</sup>, C. Han<sup>4,5,6,7</sup>, A. Gould<sup>8,9</sup>, T. Sumi<sup>10,11</sup>, A. Udalski<sup>12,13</sup>, J.-P. Beaulieu<sup>14,15</sup>, R. Street<sup>16,17</sup>, M. Dominik<sup>18</sup>

W. Allen<sup>19</sup>, M. Bos<sup>19</sup>, G.W. Christie<sup>19</sup>, D.L. DePoy<sup>19</sup>, S. Dong<sup>19</sup>, J. Drummond<sup>19</sup>, A. Gal-Yam<sup>19</sup>, B.S. Gaudi<sup>19</sup>, C.B. Heald<sup>19</sup>, L.-W. Hung<sup>19</sup>, J. Jang<sup>19</sup>, C.-U. Lee<sup>19</sup>, J. Mashhal<sup>19</sup>, A. Maslan<sup>19</sup>, J. McCorrick<sup>19</sup>, D. McGregor<sup>19</sup>, L.A.G. Monari<sup>19</sup>, D. Moorhouse<sup>19</sup>, J. A. Muna<sup>19</sup>, T. Natsume<sup>19</sup>, C. Nelson<sup>19</sup>, B.-G. Park<sup>19</sup>, R.W. Pogge<sup>19</sup>, T.-G. Tan<sup>19</sup>, G. Thone<sup>19</sup>, J.C. Yee<sup>19</sup>

(THE  $\mu$ FUN COLLABORATION),

F. Abe<sup>20</sup>, E. Barnacka<sup>20</sup>, J. Baskin<sup>20</sup>, D.P. Bennett<sup>20</sup>, J.A. Bird<sup>20</sup>, C.S. Bratton<sup>20</sup>, M. Freeman<sup>20</sup>, A. Fukui<sup>20</sup>, K. Furusawa<sup>20</sup>, F. Hasegawa<sup>20</sup>, J.B. Heald<sup>20</sup>, S. Hoggak<sup>20</sup>, Y. Ito<sup>20</sup>, K. Kaneko<sup>20</sup>, P.M. Kubit<sup>20</sup>, S. Kobayashi<sup>20</sup>, A. Korpi<sup>20</sup>, W. Lin<sup>20</sup>, C.H. Ling<sup>20</sup>, S. Martin<sup>20</sup>, K. Masuda<sup>20</sup>, Y. Matsumoto<sup>20</sup>, N. Miyake<sup>20</sup>, Y. Miyake<sup>20</sup>, M. Nagata<sup>20</sup>, K. Nishimoto<sup>20</sup>, K. Okada<sup>20</sup>, T. Okuma<sup>20</sup>, K. Ohno<sup>20</sup>, Y.C. Preidert<sup>20</sup>, N. Ratzenburg<sup>20</sup>, T. Sato<sup>20</sup>, I. Saklani<sup>20</sup>, D.J. Sullivan<sup>20</sup>, D. Suzuki<sup>20</sup>, K. Suzuki<sup>20</sup>, W.I. Swatnam<sup>20</sup>, S. Takino<sup>20</sup>, P.J. Tristram<sup>20</sup>, K. Wada<sup>20</sup>, P.C.M. Yock<sup>20</sup>

(THE MOA COLLABORATION),

M.K. Szymanski<sup>16</sup>, M. Kubak<sup>16</sup>, G. Pietrzyński<sup>16,1</sup>, I. Soszyński<sup>16</sup>, R. Poleski<sup>16</sup>, K. Ulaczyk<sup>16</sup>, L. Wyrzykowski<sup>16,21</sup>, S. Kozłowski<sup>17</sup>, P. Pietrukiewicz<sup>16</sup>

(THE OGLE COLLABORATION),

M.D. Albrow<sup>12</sup>, E. Bacheler<sup>12</sup>, V. Batista<sup>12</sup>, C. Bennett<sup>12</sup>, B. Bowens-Rubin<sup>12</sup>, S. Brillant<sup>12</sup>, A. Cassan<sup>12</sup>, A. Cole<sup>12</sup>, E. Corrales<sup>12</sup>, Ck. Couturas<sup>12</sup>, S. Dieter<sup>12</sup>, D. Domoszlów<sup>12</sup>, J. Domoszlów<sup>12</sup>, P. Fouquet<sup>12</sup>, J. Greenhill<sup>12</sup>, S. Koo<sup>12</sup>, S. Koo<sup>12</sup>, J. Menzies<sup>12</sup>, K. C. Sarin<sup>12</sup>, J. Wambsganss<sup>12</sup>, A. Williams<sup>12</sup>, M. Zib<sup>12</sup>

(THE PLANET COLLABORATION)

15R] 17 NOV 2011

# Sumário

O Sistema Triplo LHS 1070

Buscando por Exoplanetas ao Redor de Sistemas Binários  
Eclipsantes e Sistemas Planetários com Trânsitos

Caracterização de Sistemas Binários Eclipsantes do tipo HW Vir

Campanha Observacional de Microlentes Gravitacionais ( $\mu$ -Fun)

Tese, Co-orientações e Sumário

- Finalização da tese programada para Junho deste ano.
- Co-orientações:  
Ayses do Carmo Oliveira;  
Isabel Lima;  
Tereza Torres.
- 1 artigo publicado, 1 artigo aceito, 3 artigos submetidos e 4 sendo finalizados.

Obrigado !

