

The DODO survey: Imaging Planets Around White Dwarfs

Emma Hogan¹, Matt Burleigh², Fraser Clarke³

¹ Gemini Observatory, ² University of Leicester, ³ University of Oxford



The aim of the Degenerate Objects around Degenerate Objects (DODO) survey is to search for very low mass brown dwarfs and extrasolar planets in wide orbits around white dwarfs via direct imaging. White dwarfs can be up to 10,000 times less luminous than their main sequence progenitors, substantially increasing the probability of directly imaging a faint, low mass companion in orbit around them. The direct detection of such companions would allow the spectroscopic investigation of objects with temperatures much lower (<500K) than the coolest brown dwarfs currently observed. The detection of a planet around a white dwarf would prove that such objects can survive the final stages of stellar evolution and place constraints on the frequency of planetary systems around their progenitors (with masses between 1.5-8 solar masses, i.e., early B to mid F). This poster presents the results of a Gemini multi-epoch J band common proper motion survey of 23 nearby equatorial and Northern hemisphere white dwarfs. We rule out the presence of any common proper motion companions, with limiting masses determined from the completeness limit of each observation, to 18 white dwarfs. For the remaining five targets, the motion of the white dwarf is not sufficiently separated from the non-moving background objects in each field. These targets require additional observations to conclusively rule out the presence of any common proper motion companions. From our completeness limits, we tentatively suggest that <5% of white dwarfs have substellar companions with effective temperatures >500K between projected physical separations of 60-200AU.

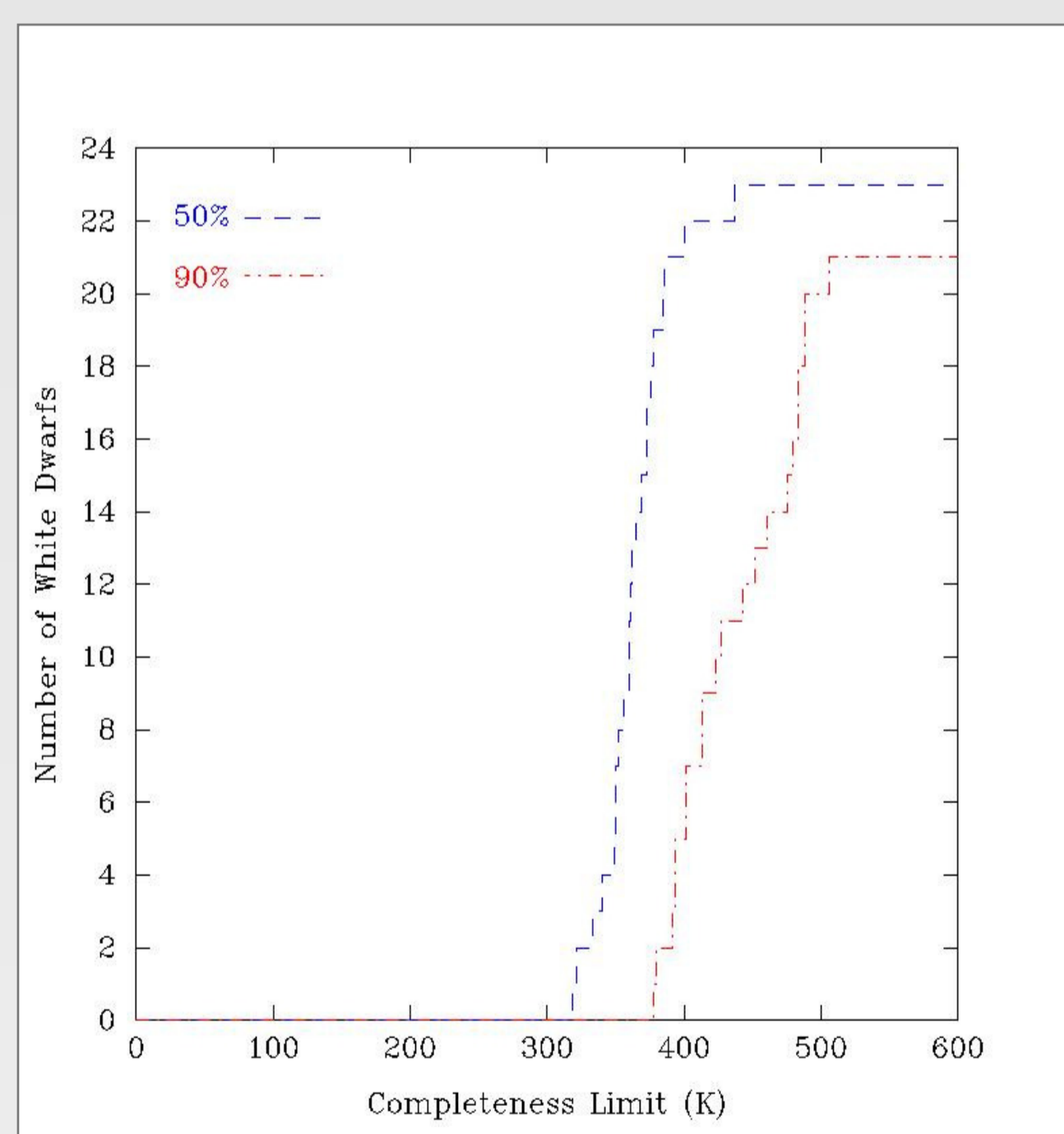
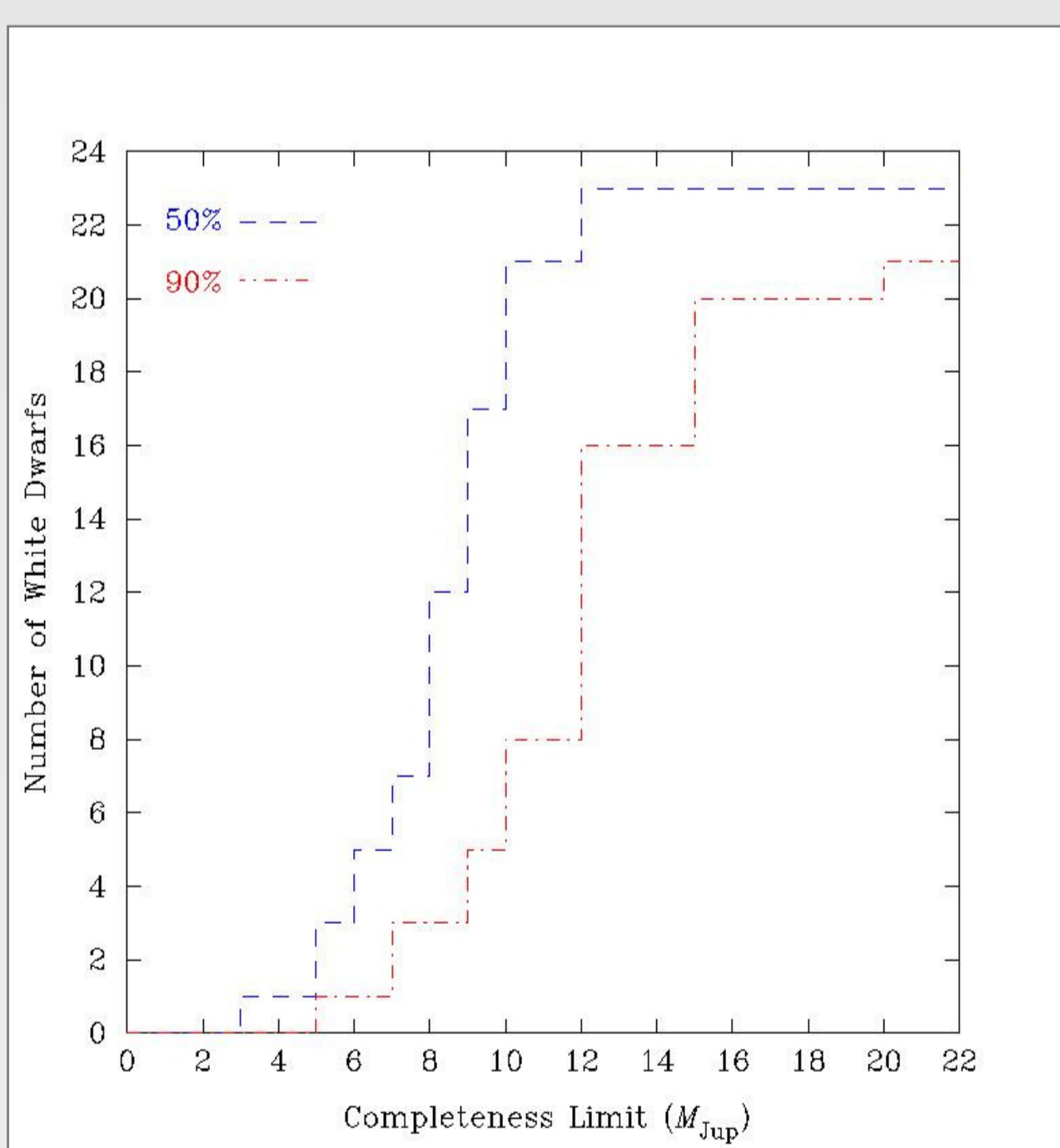
The DODO survey

wordle from <http://www.wordle.net/>

Gemini North + NIRI wide field of view
 Gemini South + FLAMINGOS
 white dwarfs within 20 pc
 directly imaging extrasolar planets
 white dwarfs younger than 4 Gyr
 multi-epoch observations
 survey began in 2002

young white dwarfs
 nearby white dwarfs
 one hour exposures
 J band images
 planetary mass companions
 companions in wide orbits
 common proper motion companions

Using the apparent magnitude at which 90% and 50% of inserted artificial stars were recovered from the images of each white dwarf, along with the total age of the white dwarf (equal to the sum of the main sequence progenitor lifetime and white dwarf cooling age), the minimum mass and effective temperature of a companion that could be detected in both epoch images of each white dwarf were estimated using the COND evolutionary models^a. The following cumulative completeness limit plots summarise these results.



White Dwarf	50% M [M _{Jup}]	50% T [K]	WD Orbit [AU]	MS Orbit [AU]
WD0115+159	8 ± 1	380	46 - 675	11 - 160
WD0208+396	9 ± 1	360	50 - 758	14 - 138
WD0644+375	8 ± 1	360	46 - 652	17 - 236
WD1055-072	9 ± 1	340	36 - 503	8 - 103
WD1134+300	3 ± 1	350	46 - 664	9 - 127
WD1647+591	5 ± 1	350	33 - 372	7 - 77
WD1900+705	5 ± 1	350	39 - 452	8 - 89
WD1953-011	8 ± 1	360	34 - 509	7 - 111
WD2007-219	7 ± 1	370	55 - 831	12 - 189
WD2326+049	6 ± 1	370	41 - 396	9 - 89

The results of a selection of equatorial and Northern hemisphere white dwarfs from the DODO survey. The “50% M” and “50% T” columns show the completeness limits in terms of mass, measured in Jupiter masses, and effective temperature, measured in Kelvin, respectively. “WD Orbit” and “MS Orbit” are the range of projected physical separations at which a companion of that mass could be found around the white dwarf and main sequence progenitor, respectively, measured in AU.

A possible candidate with a magnitude of J~22 appeared to have a motion similar to that of WD2007-219 between the 2002 first epoch and 2003 second epoch images (left hand figure). A third epoch image was recently acquired to determine whether this apparently co-moving candidate was a genuine common proper motion companion. Sadly, the new, more sensitive (middle figure) observation showed that this object is in fact a non-moving background object (right hand figure). New images of the five targets that require third epoch observations are currently being analysed and the results will be published in an upcoming paper later this year.

