

# **RED DOTS 2017: Photometry Guidelines**

## **Introduction**

The aim of the Red Dots campaign is to find exoplanets orbiting around three M-Dwarf stars in the solar neighbourhood. This campaign is a follow up to the very successful Pale Red Dot campaign from last year that resulted in the discovery of exoplanet Proxima b. The campaign runs from 15th June to 5th October and the three stars being observed are GJ729 (AUID = 000-BCX-044), Proxima Centauri (AUID = 000-BCV-333) and Barnard's star (AUID = 000-BDB-728).

The campaign involves the use of the HARPS high resolution spectroscope in ESO's La Silla Observatory in Chile in order to obtain radial velocity measurements for the stars. In addition, photometric observations of the target stars will also be performed from the LCOGT, MONET-N, MONET-S, MONTSEC, ASH and ASH2 observatories. We also request here photometric observations from amateur observers who are members of the AAVSO or other amateur organisations. The photometric data will be used to monitor activity on the stars as well as identify exoplanet transits.

This document details the requirements for performing photometry for members of AAVSO and other amateur astronomers contributing to the campaign. It also details the requirements for uploading the photometric data to the AAVSO database. The document contains the following sections:

- Photometric Requirements – details target stars and comparison stars along with star charts and the location details for them
- Data Capture and Reduction methods – details the process to produce scientifically valid photometric measurements of the target stars
- Data Upload Requirements – details the file format for the photometric data and the method to upload the files to the AAVSO database

## **Photometric Requirements**

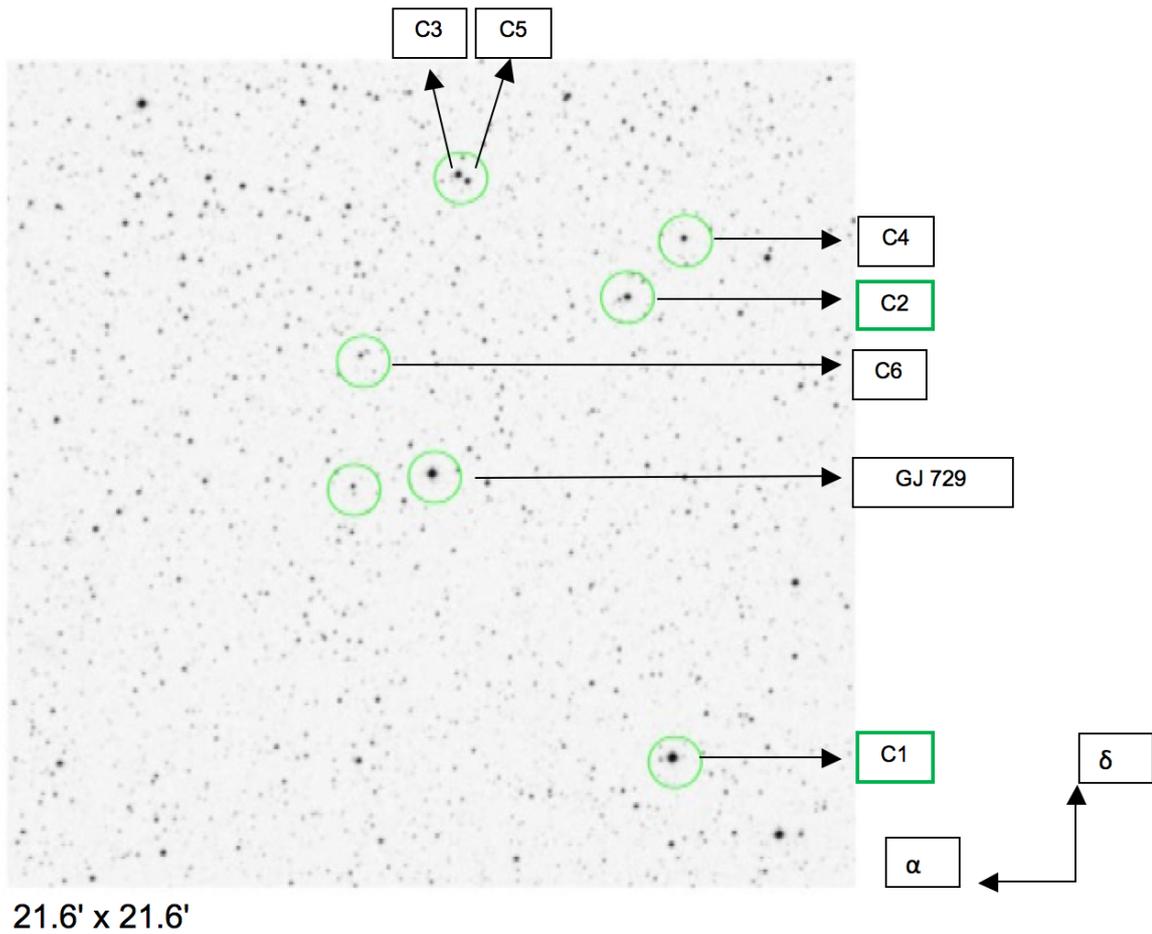
All exposures should be taken with a black and white CCD camera whose temperature can be regulated.

### **Target star GJ729 (AUID = 000-BCX-044)**

The most urgent requirement we have for photometry is for the active star GJ729 where we would like to obtain as close to 24 hour per day coverage so that we can understand its activity and be able to disentangle this activity from any exoplanet signals that may be present.

Observations should be done in the V-band and with comparison star C1. The star

chart is given below:



The  $\alpha$  and  $\delta$  axis symbols refer to the orientation of the chart in terms of right ascension and declination respectively.

The right ascension and declination for GJ 729 at epoch year 2000 is given below along with its proper motion (PPM) in milliarcseconds per year:

$\alpha_{2000}$ : 18 49 49.4 / ppm ( $\alpha$ )= 637 mas/yr

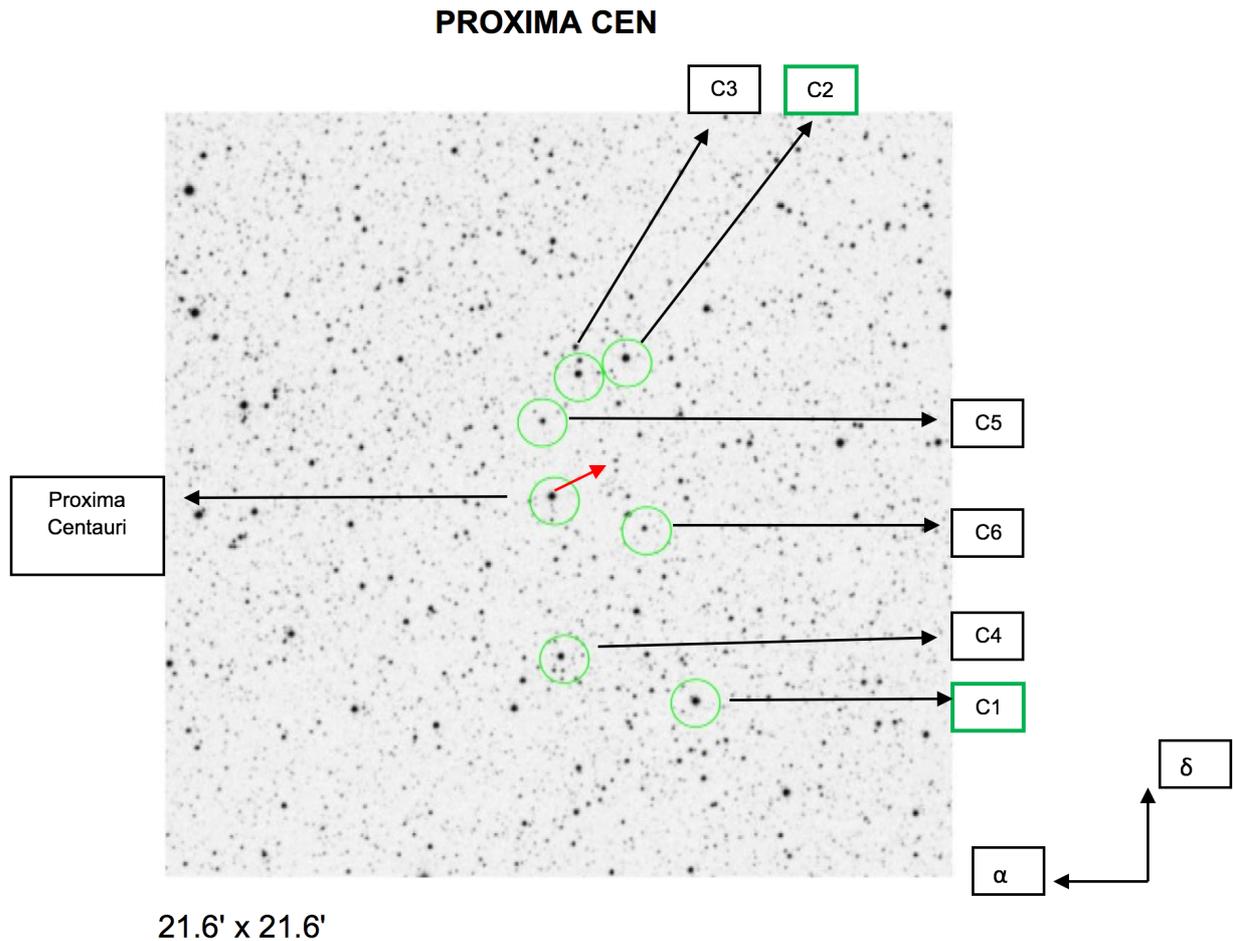
$\delta_{2000}$ : -23 50 10 / ppm ( $\delta$ )= -192 mas/yr

The magnitudes of GJ729 and the comparison star are detailed below for different colour bands:

	GJ 729	C1: CD-24.14735
B	12.24	12.14
V	10.50	10.3
R	9.28	-
I	7.70	-
Sp. Type	M 3.5 V	-

## Target star Proxima Centauri (AUID = 000-BCV-333)

Photometric observations are required for Proxima Centauri in order to search for potential exoplanet transits from Proxima b or other as yet unknown exoplanets and in order track activity on the star due to flares. Photometry should be done in the V band and comparison star C1 should be used. The star chart with locations of Proxima Centauri and the comparison star are shown below:



The  $\alpha$  and  $\delta$  axis symbols refer to the orientation of the chart in terms of right ascension and declination respectively.

The right ascension and declination for Proxima Centauri at epoch year 2000 is given below along with its proper motion (PPM) in milliarcseconds per year:

Proxima Cen:

$\alpha_{2000}$ : 14 29 42.9 / ppm ( $\alpha$ )= -3776 mas/yr

$\delta_{2000}$ : -62 40 46 / ppm ( $\delta$ )= 766 mas/yr

The red arrow in the diagram shows the direction of the high proper motion of

Proxima Centauri with respect to the background stars.

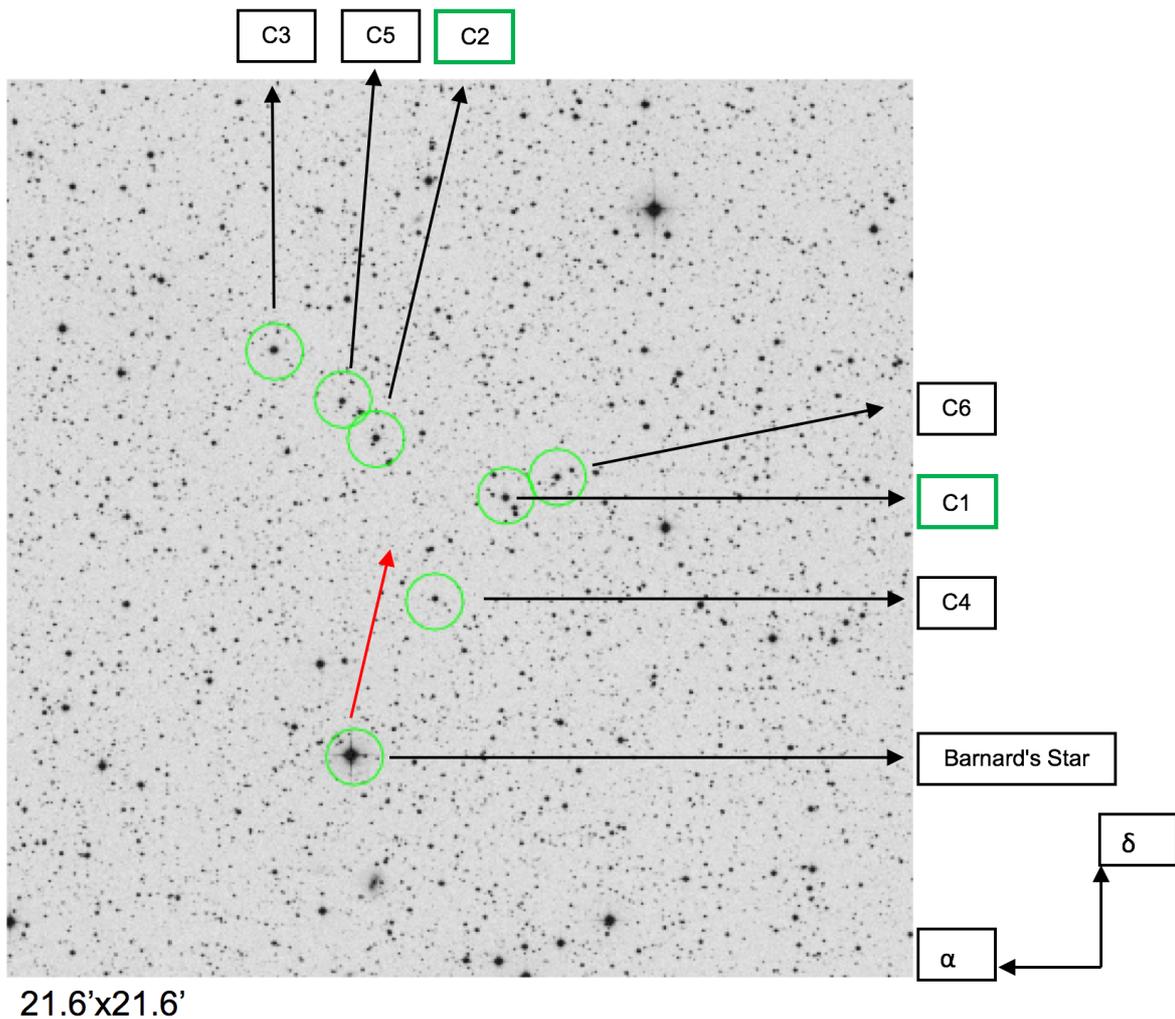
The magnitudes for Proxima Centauri and its comparison star C1 are given in the following table:

	Proxima Cen	C1: HD126625
B	12.95	10.53
V	11.13	10.18
R	9.45	-
I	7.41	-
Sp. Type	M 5.5 V	F8 III/IV

### **Target star Barnard's star (AUID = 000-BDB-728)**

Barnard's star is the fourth closest star to our Sun and to this date no exoplanets have been found orbiting the star. Photometric measurements are required to capture stellar activity from occasional flares this star is known to have along with looking for potential exoplanet transits. Photometric measurements are required in the V band. The star chart with the locations of Barnard's star and its comparison star C2 are given below:

## BARNARD'S STAR (GJ 699)



21.6'x21.6'

The  $\alpha$  and  $\delta$  axis symbols refer to the orientation of the chart in terms of right ascension and declination respectively.

The right ascension and declination for Barnard's Star at epoch year 2000 is given below along with its proper motion (PPM) in milliarcseconds per year:

Barnard's star:

$\alpha_{2000}$ : 17 57 48.5 / ppm ( $\alpha$ )= -799 mas/yr

$\delta_{2000}$ : +04 41 36 / ppm ( $\delta$ )= 10328 mas/yr

The red arrow in the diagram shows the direction of the high proper motion of Barnard's Star with respect to the background stars.

The magnitudes for Barnard's Star and its comparison star C2 are given in the following table:

	Barnard's	C2: 2MASS-J17574653+0447466
B	11.24	13.25
V	9.51	12.21
R	8.30	11.30
I	6.74	-
Sp. Type	M 4.0V	-

## Data Capture and Reduction Methods

For those that are not familiar with data reduction methods for photometry we will be putting instructions up on the red dots website when it goes live on 15<sup>th</sup> June.

## Data Upload Requirements

In order to upload data you need to set up an AAVSO account for yourself at <https://www.aavso.org/apps/register/> and then obtain a unique AAVSO code for your observatory from <https://www.aavso.org/observers>.

Observations can be entered individually or can be uploaded using a file which is the preferred option especially if you have more than one observation. You can perform the uploads on the AAVSO website at <https://www.aavso.org/webobs>

The files to be uploaded need to be ASCII format.

The text file that is to be uploaded is in AAVSO Extended File format. Full details of this format can be found on the AAVSO website at <https://www.aavso.org/aavso-extended-file-format> but an example of the contents of the file we require is given below along with an explanation of its contents.

```
#TYPE=Extended
#OBSCODE=ABCD
#SOFTWARE=ImageJ
#DELIM=,
#DATE= JD
#OBSTYPE=CCD
#NAME,DATE,MAG,MERR,FILT,TRANS,MTYPE,CNAME,CMAG,KNAME,KMAG,AMASS,GROUP,CHART,NOTES
000-BCX-044,2450702.1234,11.235,0.003,V,NO,DIF,C1,10.593,na,na,1.561,na,na,na
000-BCX-044,2450702.1254,11.135,0.003,V,NO,DIF,C1,10.594,na,na,1.563,na,na,na
000-BCX-044,2450702.1274,11.035,0.003,V,NO,DIF,C1,10.594,na,na,1.564,na,na,na
000-BCX-044,2450702.1294,10.935,0.003,V,NO,DIF,C1,10.592,na,na,1.567,na,na,na
```

The first 6 rows of the file contain mandatory parameters:

- #TYPE – the type of the file which is always value Extended
- #OBSCODE – your four digit AAVSO observatory code which you can obtain from the AAVSO website at: <https://www.aavso.org/observers>

- #SOFTWARE – the name of the software you are using
- #DELIM – the delimiter between fields. This value should be the comma.
- #DATE – the date format which should be JD standing for Julian Date
- #OBSTYPE – this field specifies the type of observation and should be CCD.

The next row starts with a # and lists the set of fields which are populated in each row below. The fields for each row are:

- NAME – name of target star. Use AAVSO Unique Identifiers (000-BCX-044 for GJ729, 000-BCV-333 for Proxima Cen, 000-BDB-728 for Barnard's Star).
- DATE – The date of the midpoint of the observation in Julian Date format e.g. 2450702.1234
- MAG – the instrumental magnitude calculated for the target star which is -  $2.5 \cdot \log(\text{counts from target star} / \text{counts from comparison star})$
- MER – the error in the instrumental magnitude of the target star (see section on Data Capture and Reduction Methods above for details)
- FILT – Name of filter used. This should V for the Johnson V filter
- TRANS – should be set to NO
- MTYPE – Magnitude type which should be set to DIF for differential
- CNAME – Name of comparison star should be C1 or C2
- CMAG – Magnitude of the comparison star
- KNAME – Set to na for not applicable
- KMAG – Set to na for not applicable
- AMASS – The airmass if known
- GROUP – Set to na for not applicable
- CHART – Put na in this field
- NOTES - Add any notes you want to add about the observation

Once you have created the files you can upload them onto the AAVSO database at <https://www.aavso.org/webobs>.

Please upload your data to the AAVSO as frequently as you can as this will mean we can use your data to help look for exoplanets as soon as possible. We will put regular updates on the campaign website at <http://www.reddots.space>. The website goes live at the start of the campaign on 15<sup>th</sup> June.