

# Chinese-Australian Collaboration in Kunlun Station AST3 Science Working Group on Exoplanets and Solar System

Co-ordinators: Chris Tinney (UNSW) and Jilin Zhou (Nanjing University)

Current Working Group Members : Daniel Bayliss (ANU), Joao Bento (Macquarie) , Michael Burton (UNSW), Brad Carter (USQ), Jonti Horner (UNSW), Haibin Zhao (PMO) , Hui Zhang (NJU), Huigen Liu (NJU), Michael Ireland (Macquarie), Jiwei Xie (NJU), Sarah Maddison (Swinburne), Chris Tiney (UNSW), Benjamin Warrington (Macquarie), Rob Wittenmyer (UNSW), Liyoing Zhou(NJU), Jilin Zhou (Nanjing University)

## Version History

1.0 Initial Draft - 15 Oct 2012

1.2 Revised following input from team members – 6 Nov 2012

1.3,1.4 Revised to include basic AST3 observing strategy.

## Introduction

The signing of an MoU between China and Australia to collaborate on the exploitation of AST3 imaging data from the Kunlun station observatory offers the prospect of some revolutionary new science being done between the two countries. This document aims to lay out some general principles which can guide this collaboration in the area of exoplanets and solar system astronomy, and to highlight specific projects that can be undertaken in these areas.

It is expect these guidelines will evolve over the next 12 months as the nature of the collaborations deepens and the specific projects to be pursued develop.

A short summary of the preliminary version of the AST3 observing plan and detection estimation is attached as an Appendix. Input on this strategy is critical – please contact Jilin or Hui for further details.

## Australian Facilities

The following Australian facilities are envisaged to be employed in this scientific collaboration.

**Faulkes Telescope South** - Robotic 2 m hosted at SSO through ANU's partnership with the Las Cumbres Observatory Global Telescope (LCOGT.net), would be used for imaging of potential transit systems to confirm transit shape and rule out close blends.

**ANU 2.3m (with WiFes)** – Spectroscopic observation of transit planet candidates from AST3 to rule out spectroscopic binaries.

**Anglo-Australian Telescope 4 m** – Precision Doppler observations with CYCLOPS2 to confirm transit planets and measure masses.

## Data Access and Planning

The time sensitive nature of the targets will require candidate information to be shared among the relevant collaborators as soon as feasible after discovery. The Chinese teams are expected to be responsible for real time data reduction of the AST3 data, and supplying candidates (with coordinates, photometric time-series and thumbnail images).

Australian astronomers are in a good position to assist with the development of an effective planet pipeline. A solar system small body pipeline will need to be developed.

Transit candidate observations are expected to begin in 2013.3, and candidates for winnowing with Australian facilities to start arriving in 2013.9.

The Australian teams will be responsible for coordinating observations with the Australian facilities.

Proposals for new time on the AAT will be submitted for semester 2013B (deadline mid-March 2013), and until such time is available small amounts of time could potentially be made available from existing projects. All photometry and spectroscopic data taken will be accessible to all collaborators, via a database accessible to all collaboration members.

Workshops in this area will be organized to facilitate effective collaboration between Chinese and Australian groups, commencing in 1<sup>st</sup> quarter 2013.

## Publications and Authorship

A policy will be developed that will guide when results are published and the determination of authorship. As a general principle, authorship on papers will result from making a meaningful contribution to the research – e.g. development or management of a pipeline, carrying out observations, analyzing data, writing the paper and so on.

## Projects

### 1. Monte-Carlo Simulation of AST3 Transit Planets

**Science Case:** Many searches for transiting planets have been unsuccessful due to poor survey design. With the frequencies of short period planets now well understood (from Kepler Mission), it is possible to create very realistic simulations of transit searches to drive surveys that can probe previously missed observational phase space. The aim here is to determine the optimal observational strategy for a transit search program with CSTAR and AST3.

**Activities:** Collaboration on designing and running a realistic MC simulation for CSTAR and AST3. Collaboration on using these results determine an optimal observing strategy.

**Outcomes:** A survey design that leads to the highest number of interesting discoveries for CSTAR and AST3.

**Australian Facilities:** Computational resources at ANU

**AST3 Requirements:** None

**Australian Co-ordinators:** Bayliss

**Chinese Co-ordinators:** Huigen, Hui

## 2. Identification of AST3 Transit Planets

**Science Case:** The identification of exoplanets from their transit signals enables huge swathes of exoplanetary science that is otherwise impossible – in particular the measurement of exoplanet densities, and stellar-spin-vs-planet-orbit misalignments.

UNSW and ANU astronomers are already engaged in a program of 'winnowing' transit candidate from HAT South using the 2.3m and Faulkes Telescopes, followed by Doppler confirmation with the AAT. These techniques are directly applicable to the winnowing and Doppler confirmation of transit planet candidates from AST3.

**Activities:** Chinese and Australian astronomers would collaborate on applications for 2.3m and AAT time; manage lists of transit candidates through the various verification phases on these telescopes; carry out and reduce observations; and publish planets transit systems.

**Outcomes:** The discovery and publication of new planetary transit systems.

**Australian Facilities:**

- ANU 2.3m + WIFES (Low-resolution spectroscopy) : ??n per semester for ?? semesters commencing 2013B
- AAT + CYCLOPS2 (high resolution spectroscopy): ??n per semester for ?? semesters commencing 2013B

**AST3 Requirements:**

- 11520 images at 9 minutes cadence for 3 days period on 1 AST3 units commencing winter 2013
- 76200 images at 18 minutes cadence for 35 days period on 1 AST3 units commencing winter 2013
- Preliminary data reduction and 100-250 candidates to be identified by high accuracy photometric and spectroscopic observations.

**Australian Co-ordinators:** Tinney, Bayliss

**Chinese Co-ordinators:** Jilin, Hui

## 3. Follow-up Observations of AST3 Transit Planets

Once AST3 transit planets are identified they will then be potential subjects for high-profile follow-up observations, including Doppler observations of spin-orbit misalignment, and atmospheric transit studies.

*The key issue to be decided here is whether this activity is pursued as an “open” one by anybody, following the publication of planets from activity 2. Or whether there is an ‘in house’ process for submitting applications for telescope time and/or doing observing before results from activity 2 go public.*

**Activities:** Collaborate on applications for AAT or 8-m telescope time; carry out and reduce observations; publish results.

**Australian Facilities:**

- AAT+CYCLOPS2 (high resolution spectroscopy): 4n per suitable transit planet, expected at the rate of 2 per year starting 2014.
- Magellan (high resolution spectroscopy): 1n per suitable transit planet, expected at the rate of 2 per year starting 2014.

**AST3 Requirements:**

- Utilizes the same AST3 data as activity 2 (see appendix for details)

**Australian Co-ordinators:** Tinney, Bayliss

**Chinese Co-ordinators:** Jilin, Hui

4. Activity of exoplanet host stars

**Science Case:** Observations of the activity of stars suspected or known to host planets are of scientific value in several respects. Starspots (especially those on rapidly rotating and hence active stars) can affect or mimic a planetary transit light curve (e.g. <http://arxiv.org/abs/0906.4320>). So starspots need to be observed to provide the most reliable and accurate knowledge regarding a planet candidate. Observations of starspots can also help to provide basic information about the host stars, by enabling measurement of the rotation period for stars with detectable spot activity, and in some cases, perhaps allow the study of spin-orbit alignment (<http://arxiv.org/abs/1103.4859>). For active stars found to be hosting exoplanets, the effect of stellar winds on the planet (<http://arxiv.org/abs/1204.3843>) and the possible effect of a close-in planet on the host star's activity can also be studied (<http://arxiv.org/abs/1204.3843>).

**Activities:** Brad Carter to fill in.

**Australian Facilities:**

- ???

**AST3 Requirements:**

- Currently envisaged to use the same AST3 data as activity 2 (see appendix for details)
- If additional data are required they need to be discussed asap!

**Australian Co-ordinator:** Carter  
**Chinese Co-ordinators:** Hui, Huigen

### 5. Discovery of new solar system small bodies

**Science Case:** Whilst the majority of the Solar system's small bodies move on orbits that mean that they can be observed world-wide, a significant fraction will, at any given time, be located in regions of the sky that are inaccessible, or poorly served, by observatories in the northern hemisphere. Telescopes in Antarctica offer an ideal opportunity to target objects in the far south which are orbiting far from the ecliptic plane.

The AST3 telescopes will, from time to time, make serendipitous discoveries of objects within our Solar system – putting in place observing strategies that maximize these discoveries (while not impacting on the core survey science being undertaken at that time) will be required.

**Activities:** 1. *A system for triggering the discovery of such objects from the AST3 catalogues is going to be required. The development of such a system will be best done in the context of the Monte-Carlo simulations envisaged for activity 1.*

2. Once such a system is triggered, follow-up observations will be required to determine orbits. The ANU's Faulkes telescope would probably be the ideal facility for these imaging observations. *Who would manage this process and reduce the data and publish new discoveries.*

Further follow-up observations following discovery and orbit measurement would include observations to further refine orbital parameters, and to determine their rotation periods, shapes, and physical properties.

Such work will involve collaboration with colleagues (*who?*) in Europe, who will be able to. Once the optical and infra-red observations are considered in concert, it will be possible to determine the size and surface properties of the objects in question, so long as sufficient observations are available. We will also perform detailed n-body integrations of the orbits of interesting objects, to attempt to determine their origins and future behaviour.

**Outcomes:** Publications detailing the discovery, dynamical and physical nature of interesting Solar system small bodies.

#### **Australian Facilities:**

- Faulkes telescope : observations to confirm AST3 detections and determine orbits. Expected at rate of 3 x 1h triggers for queue imaging per new small body detected. Small bodies expected to be detected at a rate of ??? per winter.

#### **AST3 Requirements:**

- Currently envisaged to use the same AST3 data as activity 2 (see appendix for details)
- If additional data are required they need to be discussed asap!

**Australian Co-ordinator:** Horner  
**Chinese Co-ordinator:** Liyong