The PTF Orion Planet-Search Project


ABSTRACT

The Palomar Transient Factory (PTF) is a new survey for astronomical transients to be undertaken with the wide-field CCD array recently installed on the Palomar 48" telescope. The camera consists of a 12-CCD array, each 2048 by 4096 pixels, giving a total nominal 7.8 square degree array with 1" pixels. The Orion project is an experiment that during its first year will focus on a single pointing in the Orion star-forming region as part of the PTF survey. The project has been assigned 40 consecutive nights per year for three years to perform intensive time-series observations of variable stars and other transients in the region. The primary goal of the project is to search for close-in, Jupiter-sized planets transiting young stars. Little is known about the distribution and frequency of planets around stars that are 1-100 Myr old—the time frame in which the giant planets are expected to form. Our principal goal is to investigate the frequency of planets around stars of young age. In addition, the observations will provide a unique data set to study a variety of stellar astrophysics, including: testing star formation and evolution models; characterizing stellar activity and rotational periods; and characterizing previously unknown young stars in the Orion region. Here we present the current status of the project and some of the findings from the preliminary test data.

PHOTOMETRIC CALIBRATION

DAOPHOT output photometry is zero-point corrected with a calibration against the USNO-B1.0 catalogue to obtain a rough absolute R magnitude estimate for each source detection. From the figures above:

- 4300 unflagged sources detected on chip 2 (~0.6 deg² FOV)
- R-mag. histogram implies:
  - Completeness limit at R~19.3 in 30s.
  - Saturation at R~12.5
- Curvature in zero-point plot may be due to non-linearity in USNO-B catalogue, and/or to mismatch between USNO-B and PTF R-filters.
- USNO-B precision is ~0.25mag, so curvature is not unreasonable.

In order to obtain a quick first reduction:

- No iteration of differential photometry.
- Entire chip reduced as a single ensemble.
- Only crude checking against USNO-B for confused sources.

Preliminary test data were taken during instrument commissioning time in Feb/Mar '09 with the purpose of using them to build a differential photometry pipeline. Preliminary results show:

- An overlapped tiling of the entire Orion region, R band, 60s exposures.
- A single-field time-series data set, R band, 30s exposures, ~1min cadence, over three nights.

The results presented here represent a preliminary first-cut reduction of two nights from the time-series data to begin to assess performance.

The aim is to observe a field where the disks of young stars are on the point of dissipation (~5—10Myr old), leaving behind any new born planets. The field just south of Orion's belt, chosen for the time-series test, satisfies this goal (see figures above). The noise floor starts to set in at around the 9mmag level. Rejecting data at sec z > 2.0 and seeing > 3.0" reduces this noise floor to ~4—5mmag, adequate for detecting Jupiter-sized planets, particularly if consecutive data points can be binned together.

FURTHER IMPROVEMENTS

As shown in the bottom figure, the noise floor starts to set in at around the 9mmag level. Rejecting data at sec z > 2.0 and seeing > 3.0" reduces this noise floor to ~4—5mmag, adequate for detecting Jupiter-sized planets, particularly if consecutive data points can be binned together.

SELECTING A FIELD

Choosing the final Orion project field requires a balance of local conditions and suitability of the entire Orion OB association. Nearby, small, isolated regions in the N2000 field source catalogue profile an initial handle on some of these, as well as interesting trends of dust and star formation in the Orion complex.

- Left Source count density — need unrelated field, but sufficient dense regions to avoid chance.
- Surface brightness — check for low brightness regions, including pre-main sequence and luminous young, reddened sources — high sensitivity, requiring lower magnitude imaging.
- Source detection — check for dark regions.
- Right Source count density — check for low density regions, requiring only source counts and not the counts in regions of high variability.