The NStED Exoplanet Transit Survey Service

K. von Braun[1,4,5], M. Abajian[2,4], B. Ali[2,4], R. Baker[2,4], G. B. Berriman[1,2,4], N-M. Chiu[2,4], D. R. Ciardi[1,4], J. Good[2,4], S. R. Kane[1,4], A. C. Laity[2,4], D. L. McElroy[2,4], S. Monkewitz[2,4], A. N. Payne[1,2,4], S. Ramirez[2,4], M. Schmitz[2,4], J. R. Stauffer[3,4], P. L. Wyatt[1,2,4], and A. Zhang[2,4]

[1] Michelson Science Center; [2] Infrared Processing and Analysis Center; [3] Spitzer Science Center; [4] California Institute of Technology; [5] email: `kaspar@caltech.edu`

Abstract. The NASA Star and Exoplanet Database (NStED) is a general purpose stellar archive with the aim of providing support for NASA's planet finding and characterization goals, stellar astrophysics, and the planning of NASA and other space missions. There are two principal components of NStED: a database of (currently) 140,000 nearby stars and exoplanet-hosting stars, and an archive dedicated to high-precision photometric surveys for transiting exoplanets. We present a summary of the latter component: the NStED Exoplanet Transit Survey Service (NStED-ETSS), along with its content, functionality, tools, and user interface. NStED-ETSS currently serves data from the TrES Survey of the Kepler Field as well as dedicated photometric surveys of four stellar clusters. NStED-ETSS aims to serve both the surveys and the broader astronomical community by archiving these data and making them available in a homogeneous format. Examples of usability of ETSS include investigation of any time-variable phenomena in data sets not studied by the original survey team, application of different techniques or algorithms for planet transit detections, combination of data from different surveys for given objects, statistical studies, etc. NStED-ETSS can be accessed at `http://nsted.ipac.caltech.edu`.

1. Specific Goals of NStED-ETSS

The purpose of NStED-ETSS is to make available to the astronomical community time-series data (i.e., light curves) of planet transit studies and other variability surveys in a homogeneous format, along with tools for data analysis and manipulation. The principal goals of NStED-ETSS include the following:

- Provide access to support data for ground-based and space-based missions.
- Allow the development of different or improved algorithms for transit detection or variability classification on complete existing survey data sets; for instance, to enable the detection of planets previously missed in the original study.
- Extend the time baseline for transit studies by using data sets containing the same stars, leading to increased detection efficiency, results of increased statistical significance, enhanced potential to conduct transit timing studies, etc.
- Enable improved understanding of false positives encountered in transit surveys.
- Provide access to a wealth of other astrophysical results and ancillary science not pursued in the original survey, such as studies of eclipsing binary and other variable stars or variability phenomena, stellar atmospheres (rotation, flares, spots, etc.), asteroseismology and intrinsic stellar variability, as well as serendipitous discoveries such as photometric behaviors of supernovae progenitors, etc.

478

2. ETSS Organization & Visualization

Each data set contained in ETSS features a *master file* and many *light curve files*. Tools enable the user to visualize the data and perform manipulation and analysis tasks.

The master file provides basic properties of the data set as a whole as well as global parameters about each individual light curve file. Through the NStED infrastructure, one may thus use the master file to search the data set by parameters such as unique identifiers, celestial coordinates, static photometry parameters (single-epoch magnitudes), variability filter(s), Heliocentric Julian Dates (HJD) of the first and last data points, number of observational epochs, rms dispersion about the median magnitude, existence (and frequency) of photometric outliers, χ^2 about the median magnitude, cross identification between different magnitudes, etc.

Each light curve file is associated to a unique identifier and features a header summarizing global information about the light curve, as well as the column-delimited photometry data, generally in the format HJD, magnitude, uncertainty. Thus, it is flexible and readable with all computer operating systems and can easily be translated to other formats such as VO, binary fits tables, etc.

Fig. 1 shows an example of data visualization found on the NStED-ETSS website, complete with light curve characteristics, data set reference, and links to the associated files and download scripts. The data in this plot are taken from the TrES-Lyr1 data set, donated by F. T. O'Donovan and described in O'Donovan *et al.* (2006).

3. ETSS Holdings and Future Data Sets

Fig. 2 shows the current and some near-term future data sets featured in ETSS. TrES-Lyr1, the TrES network planet transit survey of a field in Lyra, described in O'Donovan *et al.* (2006), contains $\sim 26,000$ stars with 15,500 observation epochs over 75 nights in the R and r filters. The data sets on the globular clusters (GCs) M10 and M12 contain 44,000 and 32,000 stars, respectively, with ~ 50 observational epochs in both V and I over a 500-night timespan (von Braun *et al.* 2002). The data set on the GC NGC 3201 features $\sim 59,000$ stars with 120 epochs in each V and I over the course of 700 nights (von Braun & Mateo 2001, von Braun & Mateo 2002). NGC 2301 is an open cluster and its data set contains 150 epochs in R on 4,000 stars over 14 nights (Howell *et al.* 2005, Tonry *et al.* 2005).
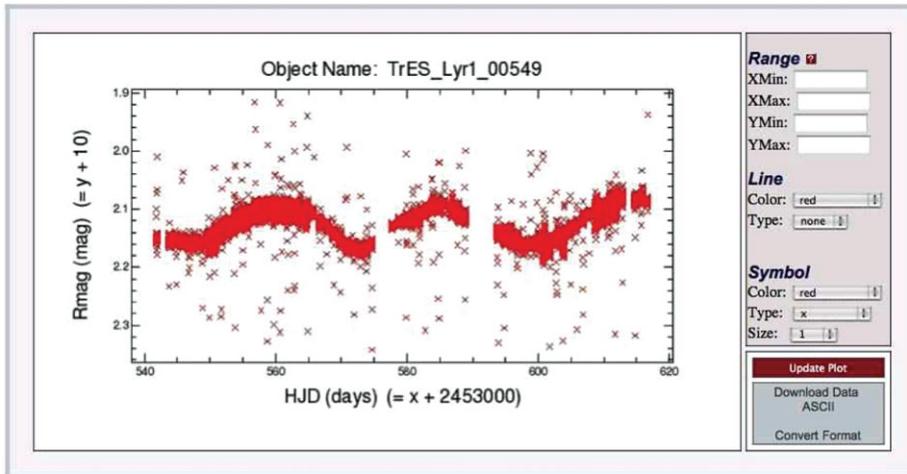
Data sets that are expected later in 2008 include the KELT-Praesepe field, described in Pepper *et al.* (2007) and Pepper *et al.* (2008), and the first two runs from the CoRoT space mission (Baglin 2006).

Further data sets that are coming soon to an NStED near you include WASP0 (PI: S. R. Kane), VULCAN (PI: N. Batalha), BOKS (PIs: S. Howell & J. J. Feldmeier), EXPLORE/OC (PIs: K. von Braun & B. L. Lee), as well as future CoRoT fields, as NStED is collaborating with the CoRoT team to provide a NASA portal to the public CoRoT data.

Each featured data set is graciously donated by the respective survey team. To increase the functionality and usefulness of ETSS, we are soliciting photometric survey data sets. The NStED webpage `http://nsted.ipac.caltech.edu` provides options to initiate the process of donating.

4. Summary

The NStED Exoplanet Transit Survey Service aims to make time-series photometry data (light curves) available to the astronomical community in a homogeneous format.

Figure 1. ETSS Detail Page: featured are an interactive light curve viewer (mag vs HJD), summary of light curve characteristics, direct links to ascii light curve, cross-identified stars (if applicable), summary table, download scripts, and the data set summary (master file). For details, see §2.

The principal goals are to increase usefulness of the survey data sets by enabling the extraction of additional scientific results from the data. ETSS is designed to be straightforward to use and clearly documented. It is continuously updated to reflect the ingestion of newly donated data sets as well as the ongoing development of tools to analyze and manipulate the data contained in the archives. NStED-ETSS is accessible via the NStED homepage at `http://nsted.ipac.caltech.edu`.
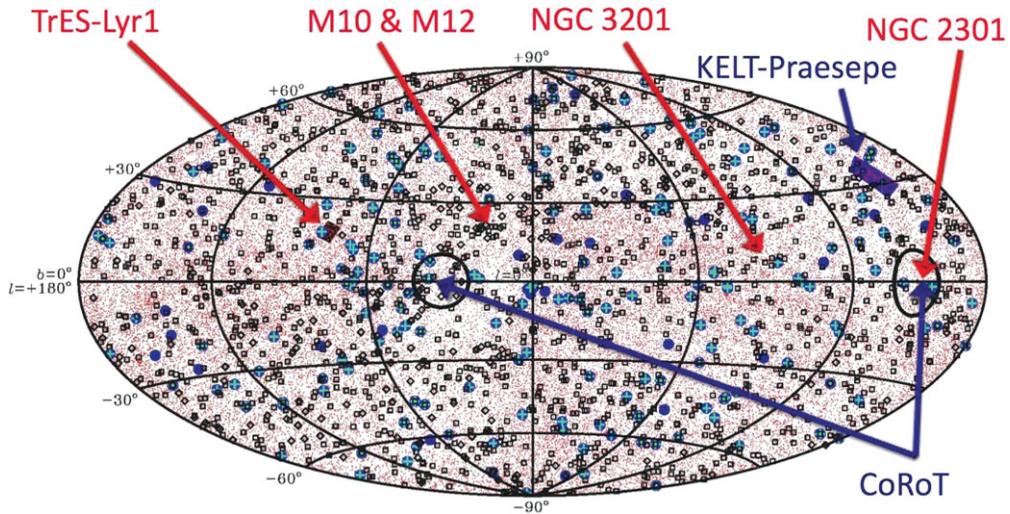
Figure 2. NStED-ETSS Contents: Aitoff projection with the locations of the current and future survey data sets. For an explanation of points and squares, please see companion paper on the NStED Stellar Service (Ramirez *et al.* 2008, this volume). Shown are the locations of the three globular clusters (M10, M12, NGC 3201), the open cluster (NGC 2301), and the TrES-Lyr1 field, all of which are contained in the current version of NStED-ETSS. Also shown are future data sets: two CoRoT fields (circles along the Galactic plane), and the KELT-Praesepe data set; both are expected later this year. For details, see §3.

References

Baglin, A. 2006, in The CoRoT Mission, *ESA-SP-1306*, 33

Howell, S. B., VanOutryve, C., Tonry, J. L., Everett, M. E., & Schneider, R. 2005, *PASP*, 117, 1187

O'Donovan, F. T., *et al.* 2006, *ApJ*, 651, L61

Pepper, J., Stanek, K. Z., Pogge, R. W., Latham, D. W., DePoy, D. L., Siverd, R., Poindexter, S., & Sivakoff, G. R. 2008, *AJ*, 135, 907

Pepper, J., *et al.* 2007, *PASP*, 119, 923

Tonry, J. L., Howell, S. B., Everett, M. E., Rodney, S. A., Willman, M., & VanOutryve, C. 2005, *PASP*, 117, 281

von Braun, K. & Mateo, M. 2001, *AJ*, 121, 1522

von Braun, K. & Mateo, M. 2002, *AJ*, 123, 279

von Braun, K., Mateo, M., Chiboucas, K., Athey, A., & Hurley-Keller, D. 2002, *AJ*, 124, 2067