The NStED Exoplanet Transit Survey Service

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Abstract & Introduction: 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 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 NStED Exoplanet Transit Survey Service (NStED-ETSS) 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. We illustrate the use of ETSS and show examples of the data contained in the database.

Overview

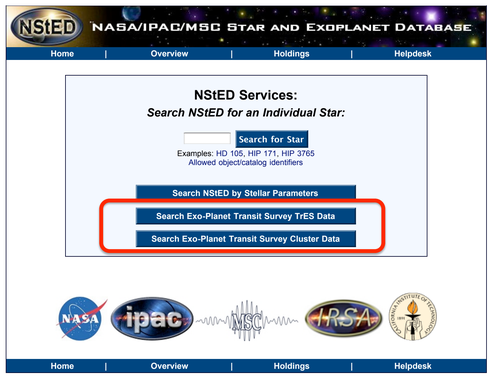

Fig. 1: NStED Home Page (http://nsted.ipac.caltech.edu). The red rectangle marks the access to the ETSS holdings.

Specific Goals of NStED ETSS

- Planet Transit Searches
  - Extend time baseline (increase detection efficiency, increase statistical significance of results, transit timing studies, etc).
  - Allow new algorithm and variability classification development.
- Support data for ground- and space-based missions
- General astrophysics and ancillary science
  - (Eclipsing) Binary systems and other variable stars.
  - Stellar atmospheres (e.g., rotation, spots, and flaring).
  - Asteroseismology and stellar variability.
  - Serendipity (e.g., SN progenitor).
- Improved understanding of transit false positives.
- Tools for analysis and data manipulation.

ETSS Organization

- **Master File** (Fig. 4) for each dataset enables queries
  - Unique identifier
  - Coordinates
  - Static photometry
  - Variability filter
  - Start/End dates
  - Number of epochs
  - Dispersion about median of light curve
  - Existence and frequency of outliers
  - χ^2 about the median
  - Cross-identification of stars appearing multiple times
  - Fields for one dataset but not in other datasets are place-marked as 'null'
    - Enables expansion
    - Most commonly seen in static photometry
- Associated to each unique ID is a **Light Curve** (Fig. 3)
  - Header summarizes master file information for light curve
  - Simple ASCII, column delimited HJD, mag, sigma
  - Flexible – easily readable from machine to machine
  - Easily translated to other formats (e.g., VO, binary fits table)

Products

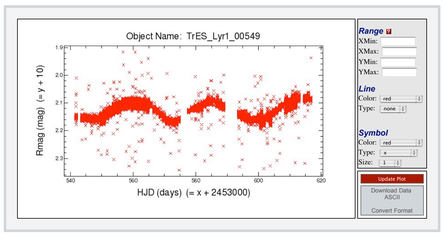

Fig. 2: ETSS Detail Page: featured are an interactive light curve viewer (mag vs HJD), summary of light curve characteristics, direct links to ascii **light curve** (see Fig. 4), cross-identified stars (if applicable), summary table, download scripts, the data set summary (**master file**, see Fig. 5).

Fig. 5: ETSS Master File in ascii format, listing basic properties of the data set as a whole, explanations of column headers, and static photometry results and light curve characteristics for each star in the data set.

```
\Region = M12
\Variability_Filter1 = I
\Variability_Filter2 = V
\Reference1 = von Braun et al. 2002, AJ, 124, 2067
\Reference2 = von Braun 2003, PASP, 115, 272
\ STARID = unique identification for star within dataset: Cluster_Filter_Num
\ RA = Right Ascension of star in decimal degrees (J2000)
\ Dec = Declination of star in decimal degrees (J2000)
\ Bmag = Median value of apparent B magnitude
\ Berr = Observational uncertainty on B magnitude
\ Rmag = Median value of apparent R magnitude
\ Rerr = Observational uncertainty on R magnitude
\ Vmag = Median value of apparent V magnitude
\ Verr = Observational uncertainty on V magnitude
\ Imag = Median value of apparent I magnitude
\ Ierr = Observational uncertainty on I magnitude
\ LCfil = name of filter in which lightcurve was obtained
\ Npts = Number of datapoints in lightcurve
\ StartHJD = minimal value of Julian date in lightcurve (mid-exposure)
\ EndHJD = maximum value of Julian date in lightcurve (mid-exposure)
\ LCdisp = 1-sigma rms dispersion of lightcurve around median value of lightcurve
\ LCchisq = chi-squared of lightcurve about median lightcurve value
\ N5sig = number of lightcurve points beyond 5-sigma of lightcurve median value
\ F5sig = fraction of lightcurve points beyond 5-sigma of lightcurve median value
\ Duplicate1 = name of star in the other filter
\ Public = Y/N keyword indicating if lightcurve data available to public
\ Dataset = identification number of dataset
\ Region = identifier for part of sky observed in survey
\ References = refereed publication referring to technical details of survey
| STARID| RA| Dec| Bmag| Berr| Rmag| Rerr| Vmag| Verr| Imag| Ierr| LCfil| Npts| StartHJD| EndHJD| LCdisp| LCchisq| N5sig| F5sig| Duplicate1| Duplicate2| Public| Dataset| Region| Reference1| Reference2| Reference3|
M12_I_15 251.603492 -2.118218 null null null null 17.657000 0.017000 16.818000 0.012000 I 20 2450566.79751833 2451051.53521433 0.019000 1.400000 1 0.050 M12_V_15 null Y 3 M12 von Braun et al. 2002, AJ, 124, 2067 von Braun 2003, PASP, 115, 272 null
M12_I_4 251.604271 -2.046404 null null null null 22.258000 0.182000 21.079000 0.217000 I 23 2450568.81682033 2451052.59770933 0.233000 1.960000 0 0.000 M12_V_7 null Y 3 M12 von Braun et al. 2002, AJ, 124, 2067 von Braun 2003, PASP, 115, 272 null
M12_I_1 251.604456 -2.029972 null null null null 20.120000 0.028000 18.816000 0.030000 I 23 2450568.81682033 2451052.59770933 0.029000 1.040000 0 0.000 M12_V_1 null Y 3 M12 von Braun et al. 2002, AJ, 124, 2067 von Braun 2003, PASP, 115, 272 null
M12_I_33 251.604826 -2.112345 null null null null 21.550000 0.144000 19.092000 0.033000 I 27 2450566.79751833 2451052.59770933 0.056000 2.840000 1 0.037 M12_V_31 null Y 3 M12 von Braun et al. 2002, AJ, 124, 2067 von Braun 2003, PASP, 115, 272 null
```

Fig. 3: ETSS Light Curve Table in html or ascii format with self-documenting column headers, links to bulk downloading scripts, and links to **detail pages** (see Fig. 2).

```
\Region = NGC3201
\StarID = NGC3201_I_40277
\RA = 154.216898
\Dec = -46.244530
\Vmag = 16.452
\Verr = 0.026
\Imag = 15.633
\Ierr = 0.025
\LCfil = I
\Npts = 113
\StartHJD = 2450565.54050333
\EndHJD = 2450940.53079633
\BaseHJD = 2450565
\LCdisp = 0.045000
\LCchisq = 5.02
\N5sig = 0
\F5sig = 0.000
\Duplicate1 = NGC3201_V_3687
\Public = Y
\Reference1 = von Braun and Mateo 2001, AJ, 121, 1522
\Reference2 = von Braun and Mateo 2002, AJ, 123, 279
\Reference3 = von Braun 2003, PASP, 115, 272
\ Keywords required by LightCurveViewer
\Time_Type = HJD
\Time_Units = days
\Value_Type = Imag
\Value_Units = mag
\ErrorValue_Type = eImag
\ErrorValue_Units = mag
\Beginning_Value = 15.7660
\Ending_Value = 15.5350
\ STARID = unique identification for star within dataset: Cluster_Filter_Num
\ RA = Right Ascension of star in decimal degrees (J2000)
\ Dec = Declination of star in decimal degrees (J2000)
\ Vmag = Median value of apparent V magnitude
\ Verr = Observational uncertainty on V magnitude
\ Imag = Median value of apparent I magnitude
\ Ierr = Observational uncertainty on I magnitude
\ LCfil = name of filter in which lightcurve was obtained
\ Npts = Number of datapoints in lightcurve
\ StartHJD = minimal value of Julian date in lightcurve (mid-exposure)
\ EndHJD = maximum value of Julian date in lightcurve (mid-exposure)
\ BaseHJD = full day HJD that Relative_HJD starts at
\ LCdisp = 1-sigma rms dispersion of lightcurve around median value of lightcurve
\ LCchisq = chi-squared of lightcurve about median lightcurve value
\ N5sig = number of lightcurve points beyond 5-sigma of lightcurve median value
\ F5sig = fraction of lightcurve points beyond 5-sigma of lightcurve median value
\ Duplicate1 = name of star in the other filter
\ Public = Y/N keyword indicating if lightcurve data available to public
\ Region = identifier for part of sky observed in survey
\ References = refereed publication referring to technical details of survey
\ HJD = mid-point Julian date of individual data points in lightcurve
\ Relative_HJD = days since BaseHJD
\ Imag = I magnitude of individual data point in lightcurve
\ eImag = I magnitude uncertainty of individual data point in lightcurve
|          HJD|  Relative_HJD|  Imag|  eImag|
|       double|       double|  real|   real|
|             |             |   mag|    mag|
2450565.54050333  0.54050333  15.6980  0.0170
2450565.55689133  0.55689133  15.7150  0.0360
2450565.57332633  0.57332633  15.6380  0.0100
2450565.58971433  0.58971433  15.6520  0.0260
2450565.60609133  0.60609133  15.6760  0.0260
2450565.66415633  0.66415633  15.6200  0.0250
2450565.68106633  0.68106633  15.6230  0.0250
.
.
.
```

Fig. 4: ETSS Light Curve in ascii format. The header gives information on (and explanation of) light curve characteristics from static and time-series photometry. The body of the light curve simply lists HJD, mag, and error, and is thus easily converted to other formats.

Holdings

Region	Number of Stars	Variability Filter	Time Span	Number of Epochs (per filter)	PI
TrES-Lyr1	25947	*R, r*	75 nights	~15,500	O'Donovan
NGC 2301	3961	*R*	14 nights	~150	Howell & Tonry
NGC 3201	58666	*V, I*	700 nights	~120	von Braun
M 10	43930	*V, I*	500 nights	~50	von Braun
M 12	32378	*V, I*	500 nights	~50	von Braun

Table 1: The current data sets (donated by respective PI) in NStED-ETSS.

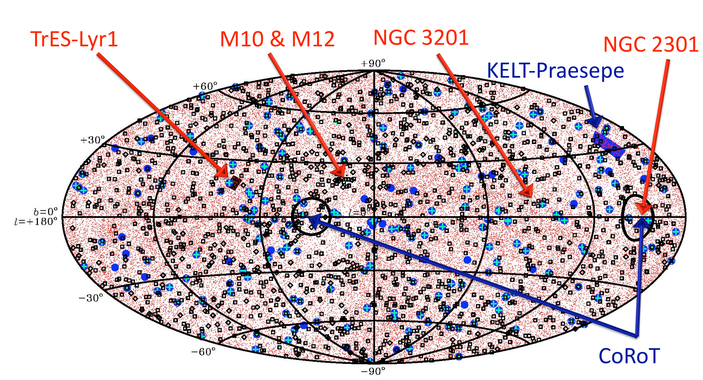

Fig. 6: NStED Contents: Aitoff projection with the locations of the **current** and **future** survey data sets. For an explanation of the blue, yellow, and red points, see companion poster on NStED Stellar Service (Ramirez et al.). Shown are the locations of the three globular clusters (**M10, M12, 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 plain), and the **KELT-Praesepe** data set; both are expected later this year.

Data Sets Coming Soon:

KELT (PI: Pepper)
CoRoT (PI: Baglin)
WASP0 (PI: Kane)
Vulcan (PI: Batalha)
BOKS (PI: Feldmeier & Howell)
EXPLORE/OC (PI: von Braun & Lee)

http://nsted.ipac.caltech.edu

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If you would like to donate call 1-GIVE-2-NSTED

References:

Baglin, A. 2006, in The CoRoT Mission, ESA SP-1306, 33
Howell, S., et al. 2005, PASP, 117, 1187
O'Donovan, F., et al. 2006, ApJ, 651, 61
Pepper, J., et al. 2007, PASP, 119, 923
Pepper, J., et al. 2008, AJ, 135, 907
Tonry, J., et al. 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., et al. 2002, AJ, 124, 2067