A layperson's guide to Kepler data.

Contents.

Introduction.

The following two tables are defined for an API provided at the NASA Exoplanet Archive. I am a layperson and a web developer. I recently participated in the International Space Apps Challenge and wrote a very basic Kepler application. I'd like to write a better one, but I didn't understand the data available to me. This is a list of the columns provided in both tables with further explanations and links for more information (the initial descriptions are provided by the API documentation). If a column has no explanation, then I either considered it obvious or not related to the information I need (I assume!).

What I would like to know about new planets is:

1. The position of, and distance to, the host star.
2. The planet's distance from its host star.
3. The mass of the planet compared to ours.
4. The size of the planet compared to ours.
5. The composition of the planet.
6. Whether or not the planet's orbit is in the "habitable zone" of the host star. There's some marked criticism on the validity of the metric, though.

Interesting columns in the exoplanets table.

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1. The position of, and distance to, the host star. My teammate in the space apps challenge used the right ascension, declination and distance to find the relative positions of the stars, but I'm intrigued by the Galactic coordinate system (st_glon and st_glat).
    - st_dist
    - ra
    - dec
    - st_glon
    - st_glat
2. The planet's distance from its host star. We'll use the semi-major axis.
    - pl_orbsmax
    - pl_orbsmaxerr1
    - pl_orbsmaxerr2
3. The mass of the planet compared to ours.
    - pl_masse

4. The size of the planet compared to ours.
    - pl_rade
5. The composition of the planet. I know that there are some exoplanets for which this is known, but I don't think this can be determined with the provided data.
    - ?
6. Habitable zone. I think the stars temperature is determined by the spectral characteristics, so st_ssp (spectral type) is probably the source of the data. However, the table specifically has st_teff, the effective temperature. Is it derived from the spectral type, though?
    - st_ssp
    - st_ssperr
    - st_teff
    - st_tefferr
    - pl_orbsmax (where the planet is)
    - pl_orbsmaxerr1
    - pl_orbsmaxerr2

Interesting columns in the Kepler candidates table.

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1. The position of, and distance to, the host star. I don't see an equivalent to st_dist from the exoplanets table. There are normd* and classprob* fields that, if I understand the Mahalonobis distance wiki properly might be the sort of raw data that gets digested to the simple st_dist. Maybe the Galactic coordinates will be easier in this case.
    - ra
    - dec
    - glon
    - glat
2. The planet's distance from its host star.
    - sma (planet-star distance)
    - smaunc (uncertainty)
3. The mass of the planet compared to ours. I was surprised to find out that Kepler can't determine the mass of the planet at all. It's the follow up observations that provide that data, so we'll only be able to get this from confirmed exoplanets in the other table.
    - ?
4. The size of the planet compared to ours.
    - prad
    - pradunc
5. The composition of the planet. The eqt (equilibrium temperature) of the (surface of the) planet might suggest something.
    - ?
6. Habitable zone.
    - sma (planet-star distance)

- smaunc
- smasrad (planet-star distance to stellar radius) The stellar radius might suggest stellar class and thereby temperature, so this may have been meant for a habitability evaluation.
- smasradun

Exoplanets table.

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This is a table of confirmed exoplanets. This isn't limited to Kepler discoveries, but since all Kepler discoveries start with 'Kepler', it can be filtered if you (I) want. The following fields are available.

pl_hostname

Planet host star name.

pl_letter

Planet letter (b, c, d, ...).

hd_name

HD name

```
A cataloguing system.
```

hip_name

HIP name

```
A cataloguing system.
```

ra

RA (deg)

```
Right ascension. I may use the right ascension and declination to
calculate the star's location in relation to us. However, the Galactic
Coordinates look promising, too.
```

dec

Dec (deg)

```
Declination.
```

st_dist

Distance (parsecs)

- st_disterr
- st_distlim
- st_plxblend

st_vj

V (Johnson) magnitude

```
Classification of stars based on color.
```

- st_vjerr
- st_vjlim
- st_vjblend

st_teff

Effective Temperature (K)

```
This is based on the class (color) of the star, so I may not use this.
```

- st_tefferr
- st_tefflim
- st_teffblend

st_rad

Stellar Radius (solar mass)

```
Radius of the star as a multiple of the sun's radius.
```

- st_raderr
- st_radlim
- st_radblend

st_mass

Stellar Mass (solar radius)

```
Mass of the star as a multiple of the sun's mass.
```

- st_masserr
- st_masslim
- st_massblend

pl_orbper

Period (days)

- (+) pl_orbpererr1
- pl_orbperlim

pl_orbsmax

Semi-Major Axis (AU)

```
In an ellipse, the distance from the center, through a focus, to the
edge.
```

- (+) pl_orbsmaxerr1
- (-) pl_orbsmaxerr2
- pl_orbsmaxlim

pl_orbincl

Inclination (deg)

```
There's an orbital plane for reference. The planet's orbital
inclination is the angle between it's orbital plane and the reference
plane.
```

- (+) pl_orbinclerr1
- (-) pl_orbinclerr2
- pl_orbincllim

pl_orbtper

Time of Periastron (Julian Days)

```
The closest approach of the planet to its star. I'm not sure what this
means in relation to days. Probably there's a day-zero point in
describing an orbit. Anyway, the 'longitude of periastron' is below.
```

- (+) pl_orbtpererr1
- (-) pl_orbtpererr2
- pl_orbtperlim

pl_orbeccen

Eccentricity

```
Amount by which the orbit deviates from a perfect circle.
```

- (+) pl_orbeccenrerr1
- (-) pl_orbeccenerr2
- pl_orbeccenlim

pl_massj

Planet Mass (Jupiter)

- (+) pl_massjerr1
- (-) pl_massjnerr2
- pl_massjlim

pl_radj

Planet Radius (Jupiter)

- (+) pl_radjerr1

- (-) pl_radjnerr2
- pl_radjlim

pl_method
: discoveryMethod

st_glon
: Galactic Longitude (deg)

```
Probably the easiest way to plot the star's position.
```

st_glat
: Galactic Latitude (deg)

st_elon
: Ecliptic Longitude (deg)

```
Probably a more confusing way to plot the star's position since it
relies on the path of the sun in the celestial sphere.
```

st_elat
: Ecliptic Latitude (deg)

st_plx
: Parallax (mas)

```
This is a method of measuring distance. Probably st_dist is a result of
this measurement.
```

- (+) st_plxerr1
- (-) st_plxerr2
- st_plxlim
- st_plxblend

st_pmra
: RA Proper Motion (mas/yr)

```
I think that this is used to calculate the position of the star and
that the galactic coordinates are probably a result of the calculation.
```

- (+) st_pmraerr1
- (-) st_pmraerr2
- st_pmralim
- st_pmrablend

st_pmdec
: Dec Proper Motion (mas/yr)

- st_pmdecerr
- st_pmdeclim
- st_pmdecblend

st_pm

Proper Motion (mas/yr)

- st_pmerr
- st_pmerrlim
- st_pmerrblend

st_radv

Radial Velocity

```
I think this is the wobble of the star, but the value is a property of
the orbiting body...) (km/sec)
```

- st_radverr
- st_radvlimn
- st_radvblend

st_ssp

Spectral Type

```
The color of the star! Sweet!
```

- st_ssperr
- st_ssplim
- st_sspblend

st_lum

Luminosity (log solar luminosity)

```
Maybe 'brightness' of the star... see Spectral Type.
```

- st_lumerr
- st_lumlim
- st_lumblend

st_metfe

[Fe/H] (dex)

```
The metallicity of the star. I just saw on the Science Channel that any
iron in a star causes the sun to go nova within minutes, so... :*
```

- st_metfeerr
- st_metfelim
- st_metfeblend

st_vsini

V sin (I) (km/sec)

```
Something to do with the rotation of the star and line-of-sight.
```

- st_vsinierr

- st_vsinilim
- st_vsiniblend

st_acts

Stellar Activity Index (S-Index)

- st_actserr
- st_actslim
- st_actsblend

st_actr

Stellar Activity Log (RHK)

- st_actrerr
- st_actrlim
- st_actrblend

st_actlx

Stellar Activit (Lx)

- st_actlxerr
- st_actlxlim
- st_actlxblend

st_nts

Number of Light Curves

```
I think the next seven fields are related to the number of measurements
taken.
```

st_nplc

Number non-HIP LCs

st_nglc

Number HIP Light Curves

st_nrvc

Number Radial Velocity Curves

st_naxa

Number Amateur Light Curves

st_nimg

Number of Images

st_nspec

Number of Spectra

st_uj

U (Johnson) magnitude

```
Photometric system.
```

- st_ujerr
- st_ujlim
- st_ujblend

st_bj

B (Johnson) magnitude

- st_bjerr
- st_bjlim
- st_bjblend

st_rc

R (Cousins) magnitude

```
Photometric system.
```

- st_rcerr
- st_rclim
- st_rcblend

st_ic

I (Cousins) magnitude

- st_icerr
- st_iclim
- st_icblend

st_j

J (2MASS) magnitude

```
Photometric system.
```

- st_jerr
- st_jlim
- st_jblend

st_h

H (2MASS) magnitude

- st_herr
- st_hlim
- st_hblend

st_k

K (2MASS) magnitude

- st_kerr
- st_klim
- st_kblend

st_irac1

IRAC 3.6 magnitude

```
Photometric system.
```

- st_irac1err
- st_irac1lim
- st_irac1blend

st_irac2

IRAC 4.5 magnitude

- st_irac2err
- st_irac2lim
- st_irac2blend

st_irac3

IRAC 5.8 magnitude

- st_irac3err
- st_irac3lim
- st_irac3blend

st_irac4

IRAC 8.0 magnitude

- st_irac4err
- st_irac4lim
- st_irac4blend

st_mips1

MIPS 24 micron flux (Jy)

```
Photometric system.
```

- st_mips1err
- st_mips1lim
- st_mips1blend

st_mips2

MIPS 70 micron flux (Jy)

- st_mips2err
- st_mips2lim
- st_mips2blend

st_mips3

MIPS 160 micron flux (Jy)

- st_mips3err
- st_mips3lim
- st_mips3blend

st_iras1

IRAS 12 micron flux (Jy)

```
Photometric system.
```

- st_iras1err
- st_iras1lim
- st_iras1blend

st_iras2

IRAS 25 micron flux (Jy)

- st_iras2err
- st_iras2lim
- st_iras2blend

st_iras3

IRAS 60 micron flux (Jy)

- st_iras3err
- st_iras3lim
- st_iras3blend

st_iras4

IRAS 100 micron flux (Jy)

- st_iras3err
- st_iras3lim
- st_iras3blend

st_umbj

(U-B) color (mags)

```
Photometric system.
```

- st_umbjerr
- st_umbjlim
- st_umbjblend

st_bmvj

(B-V) color (mags)

- st_bmvjerr
- st_bmvjlim
- st_bmvjblend

st_vjmic

(V-Ic) color (mags)

- st_vjmicerr
- st_vjmiclim
- st_vjmicblend

st_vjmrc

(V-Rc) color (mags)

- st_vjmrcerr
- st_vjmrclim
- st_vjmrcblend

st_jmh2

(J-H) color (mags)

- st_jmh2err
- st_jmh2lim
- st_jmh2blend

st_hmk2

(H-K) color (mags)

- st_hmk2err
- st_hmk2lim
- st_hmk2blend

st_jmk2

(J-K) color (mags)

- st_jmk2err
- st_jmk2lim
- st_jmk2blend

st_bmy

Stromgren (b-y) (mags)

```
Photometric system.
```

- st_bmyerr
- st_bmylim
- st_bmyblend

st_m1

Stromgren m1 (mags)

- st_m1err
- st_m1lim
- st_m1blend

st_c1

Stromgren c1 (mags)

- st_c1err
- st_c1lim
- st_c1blend

pl_orblper

Longitude of Periastron (deg)

```
The closest approach of the planet to its star. There's a pl_orbtper
which is the time of Periastron. This is the location.
```

- (+) pl_orblpererr1
- (-) pl_orblpererr2
- pl_orblperlim

pl_masse

Planet Mass (Earth)

```
Number of Earth masses in this planet. Come on, 1!
```

- (+) pl_masseerr1
- (-) pl_masseerr2
- pl_masselim

pl_rade

Planet Radius (Earth)

```
Number of Earth radiuses in this planet. Does this matter if the mass
is near-Earth? I'm thinking of tiny planets like Le Petit Prince. Or a
big fluffy pillow planet...
```

- (+) pl_radeerr1
- (-) pl_radeerr2
- pl_radelim

pl_rads

Planet Radius (solar)

```
Probably the number of sun-radiuses in the planets, but...that doesn't
seem to be useful since the sun is quite large. Maybe there are planets
that big? I think I have all I need with the other fields, so I'll
ignore this.
```

- (+) pl_radserr1
- (-) pl_radserr2
- pl_radserrlim

pl_tran

Transit Flag (1=yes, 0=no)

```
There has to be a transit to measure it in the first place. I don't
know what this means.
```

pl_trandep

Transit Depth (percentage)

- (+) pl_trandeperr1
- (-) pl_trandeperr2
- pl_trandeplim

pl_trandur

Transit Duration (days)

- (+) pl_trandurerr1
- (-) pl_trandurerr2
- pl_trandurlim

pl_tranmid

Transit Mid-point (Julian days)

- (+) pl_tranmiderr1
- (-) pl_tranmiderr2
- pl_tranmidlim

pl_disc

Discovery Year

pl_status

Planet Status

```
In this table, they're all 3. I think 3 is 'confirmed'.
```

pl_pelink

Planet Encyclopedia

```
Link to more data.
```

pl_edelink

Exoplanet Data Explorer

```
Link to more data.
```

Kepler candidates table.

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kepid

Unique Kepler Identifier

ra

RA (deg)

```
Right ascension, used for finding the star in the celestial sphere.
```

dec

Dec (deg)

```
Declination, used for finding the star in the celestial sphere.
```

kepmag

Kepler-band Magnitude

```
The only search results I found were people providing the same data. I
guess it's just a measurement of the brightness of the star. The
following site gave it's range as 2.982 to 25.0.

http://archive.stsci.edu/kepler/kic10/help/columns.html
```

teff

Effective Temperature (K)

```
It's based on the class of the star.
```

logg

Surface Gravity (cm/s?)

```
The exoplanets table doesn't have this information for the Kepler
planets. Maybe it's implicit in the mass/radius calculations.
```

radius

Stellar Radius (solar radius)

```
Radius of the host star as a multiple of the sun's radius.
```

mass

Stellar Mass (solar mass)

```
Mass of the host star as a multiple of the sun's mass.
```

stflag

Flag for origin of stellar parameters:

0: Teff,log(g), and Rad are derived using KIC J-K color and linear interpolation of luminosity class V stellar properties of Schmidt-Kaler (1982).

1: KIC Teff and log(g) are used as initial values for MCMC parameter search of Yonsei-Yale stellar evolution models yielding Teff, log(g), and Rad.

2: Teff, log(g), and Rad are derived using SPC spectral synthesis and interpolation of the Yale-Yonsei evolutionary tracks.

3: Teff, log(g), and Rad are derived using SME spectral synthesis and interpolation of the Yale-Yonsei evolutionary tracks.

cdpp6

Combined 6 hour differential photometric precision (rms of quarters 1 through 6 in units of parts per million)

kepoi_name

Kepler object of interest name for display (KNNNNN.DD)

```
Catalog.
```

kepler_name

Kepler name for confirmed planets (e.g. Kepler-6b)

kepoi_type

KepOI Type (CANDIDATE, CANDIDATE-FOP (a candidate being studied by the Kepler Mission Follow-up Observing PRogram), CONFIRMED, FALSE POSITIVE)

```
This is a planet status.
```

period
Period

periodunc
Period uncertainty (days) in BKJD=BJD-2454833

epoch
Transit epoch (days)

```
The values are more than 100 and less than 400. I think this is number
of days it took for the planet to pass in front of the star, but 300+
days seems like a lot.

Perhaps the epoch is the days from a reference point, like the start of
the mission.
```

epochunc
Transit epoch uncertainty (days)

depth
Transit depth (ppm)

```
NASA's Kepler mission site gives this as "the fractional change in
brightness". "Depth" probably refers to the dip in the light curve.
```

depthunc
Transit depth uncertainty (ppm)

duration
Transit duration

durationunc
Transit duration uncertainty (hours)

impact
Impact parameter

```
My searches only return things about the social and scientific impact
of the mission, not a description of what this measurement means.
```

impactunc
Impact parameter uncertainty

occdp
Occultation depth (Relative flux level at phase=0.5 divided by noise)

```
Probably related to transit depth. I don't think I need this field.
```

occdpunc
Occultation depth uncertainty

sma
Planet-star distance (AU); note that is the semi-major axis when eccentricity = 0

smaunc
: Planet-star distance uncertainty (AU)

smasrad
: Planet-star distance to Stellar Radius Ratio

```
This can probably be used to evaluate the habitable zone.
```

smasradun
: Planet-star distance to Stellar Radius Ratio uncertainty

pradsrad
: Planet to Stellar Radius Ratio

```
This can probably be used to evaluate the habitable zone.
```

pradsradunc
: Planet to Stellar Radius Ratio uncertainty

prad
: Planet Radius (Earth radius)

```
Radius of the planet as a multiple of Earth's radius.
```

pradunc
: Planet Radius (Earth radius) uncertainty

eqt
: Equilibrium temperature (K)

```
On the wiki page for Kepler-11g, the equilibrium temperature is the
surface temperature of the planet in the absence of atmospheric
effects. Probably this is a function of the class of the host star and
the planets orbital distance.
```

eqtunc
: Equilibrium temperature uncertainty (K)

tm_designation
: 2MASS name

glon
: Galactic Longitude (deg)

glat
: Galactic Latitude (deg)

gmag
: g'-band magnitude

rmag
: r'-band magnitude

imag
: i'-band magnitude

zmag
: z'-band magnitude

gredmag

GRED-band magnitude

d51mag

D51-band magnitude

jmag

J-band magnitude

hmag

H-band magnitude

kmag

K-band magnitude

grcolor

(g'-r') color magnitude

jkcolor

(J-K) color magnitude

gkcolor

(g'-K) color magnitude

feh

[Fe/H] (dex)

```
Metallicity of the star.
```

ebminusv

E(B-V) reddening (mag)

av

Av extinction (mag)

vsini

V sin (i) (km/sec)

parallax

Parallax (arcsec)

```
Method of measuring distance.
```

pmtotal

Proper Motion (arcsec/year)

pmra

RA Proper Motion (arcsec/year)

pmdec

Dec Proper Motion (arcsec/year)

rv

Radial Velocity (km/sec)

```
The wobble of the star.
```

galaxy

Star/Galaxy Flag (0=star, 1=galaxy)

```
All the values in this table are 0. This is probably cruft from another
database schema.
```

blend

Blend Flag

variable

Constant/Variable Flag (0=constant, 1=variable)

```
All 0 in this table.
```

fov_flag

FOV Flag (0=outside, FOV, 1=non-target, 2=target)

crowding

Fraction of flux (target/total)

neb

Number of Eclipsing Binaries

ncen

Number of Centroid Values

nts

Number of Time Series

nlc

Number of Long Cadence

nsc

Number of Short Cadence

normd1

Normalized Mahalonobis distance to most probable class (class 1)

normd2

Normalized Mahalonobis distance to second most probable class (class 2)

normd3

Normalized Mahalonobis distance to third most probable class (class 3)

classprob1

Relative probability for class 1

```
Presumably this refers to the planet, however, the only thing I could
find is the Sudarsky extrasolar planet classification which actually
has five classes. Maybe the Kepler candidates are only part of the
first three classes somehow.
```

Sudarsky extrasolar planet classification.

classprob2

Relative probability for class 2

classprob3

Relative probability for class 3

classcode1

Variability class 1

classcode2

Variability class 2

classcode3

Variability class 3

spf1

Significance parameter frequency 1 (probability)

```
Unproductive search for "significance astronomy" and "significance
parameter frequency".
```

spf2

Significance parameter frequency 2 (probability)

spf3

Significance parameter frequency 3 (probability)

freq1

Frequency 1 (cycles per day)

freq2

Frequency 2 (cycles per day)

freq3

Frequency 3 (cycles per day)

amp11

Amplitude of 1st harmonic of frequency 1 (mags)

amp12

Amplitude of 2nd harmonic of frequency 1 (mags)

amp13

Amplitude of 3rd harmonic of frequency 1 (mags)

amp14

Amplitude of 1st harmonic of frequency 2 (mags)

amp21

Amplitude of 2nd harmonic of frequency 2 (mags)

amp22

Amplitude of 3rd harmonic of frequency 2 (mags)

amp23

Amplitude of 4th harmonic of frequency 2 (mags)

amp24

Amplitude of 1st harmonic of frequency 3 (mags)

amp31

Amplitude of 2nd harmonic of frequency 3 (mags)

amp32

Amplitude of 3rd harmonic of frequency 3 (mags)

amp33

Amplitude of 3rd harmonic of frequency 3 (mags)

amp34

Amplitude of 4th harmonic of frequency 3 (mags)

phdiff12

Phase of amp12, if phase if amp11=0 (radians)

phdiff13

Phase of amp12, if phase if amp11=0 (radians)

phdiff14

Phase of amp13, if phase if amp11=0 (radians)

phdiff21

Phase of amp21, if phase if amp11=0 (radians)

phdiff22

Phase of amp22, if phase if amp11=0 (radians)

phdiff23

Phase of amp23, if phase if amp11=0 (radians)

phdiff24

Phase of amp24, if phase if amp11=0 (radians)

phdiff31

Phase of amp31, if phase if amp11=0 (radians)

phdiff32

Phase of amp32, if phase if amp11=0 (radians)

phdiff33

Phase of amp33, if phase if amp11=0 (radians)

phdiff34

Phase of amp34, if phase if amp11=0 (radians)

varred

Total variance reduction of the light curve (after fit subtraction)

```
I think this is how well the plot matches that dip in the light wave
that indicates a planet transit.
```

koi_flag

KOI Flag designating single transit or large uncertainties. From Borucki et al (2011): dd = KOI was detected on the basis of a single transit with the period derived from the transit duration and stellar radius.

snr

Signal to noise ratio

mes

Multiple Event Statistic; MES is the detection statistic akin to a total SNR of the phase-folded transit but constructed using the matched filter correlation statistics over phase and period.

chi

Goodness of fit metric

oeslc

Ratio of odd to even numbered transit depths dervied from light curve modeling

oesdv

Ratio of odd to even numbered transit depths reported by data validation pipeline

cenra

Centroid RA offset (arcsec); transit source position minus target star position

```
I think this means that Kepler's able to distinguish the distance to
the planet and the distance to the star. That's one fine machine.
Probably that's what all that parallax stuff is about.
```

cenraunc

Centroid RA offset uncertainty (arcsec); transit source position minus target star position

cendec

Centroid dec offset (arcsec); transit source position minus target star position

cendecunc

Centroid dec offset uncertainty (arcsec); transit source position minus target star position

cenoffset

Centroid total offset (arcsec); transit source position minus target star position

cenoffsetunc

Centroid total offset uncertainty (arcsec); transit source position minus target star position

obs

Observed quarters; Six integers indicating which quarters the star was observed.

```
I found something that referred to quarters as a segment of time for
observations.
```

dra

RA Offset of background object containing the transit

```
Is the background object the star?
```

ddec

Dec Offset of background object containing the transit

offset

Offset of background object containing the transit

bkgdepth

Background Object Transit Depth

bkgkepid

Background Object KepID

djmag

Delta J-band magnitude between background object and target

scicomm

Science team comment

```
These are additional details about the observation like "Secondary
eclipse" and "Stellar binary", not exclamations like "w00t!" or "Space
is the place!". Wholly professional.
```