```
In[1]:= Clear["Global`*"]
```

Some GW strain calculations

Eccentric orbits from the exoplanet database.

Some constants.

```
In[2]:= massSun = 1.99 × 10^30; (*kg *)massJ = 1.9 × 10^27; (* kg *)
massE = 5.97 × 10^24; (* kg *)
massJe = 317.9; (* earth masses *)
massJs = massJ / massSun; (* relative to the sun's mass *)
pc = 30.86 × 10^15; (* meters, parsec *)
au = 149.6 × 10^9; (* meters, astron unit *)
cee = 299 792 458.0; (* meters/s, speed of light *)
rscon = 2955.43; (* meters per solar mass, Schwarzschild radius *)
rscon = 2 * 6.67388 × 10^-11 * massSun / cee^2 (* solar mass Scharzschild radius *)
lunits =
 6.67388 × 10^-11 * massSun / cee^2 (* meters per solar mass, units of G=c=1 *)

Out[10]= 2955.43

Out[11]= 1477.71
```

Okay, join the astro / GR world and look at units of length for mass, etc, that is G=c=1 type of unit conversion.

```
In[12]:= masscon = 1477.71; (* m, G Msol/c^2, for 1 solar mass *)
powercon = 3.628 × 10^52; (* W, c^5/G,
W/unit since P is dimensionless in G=c=1 units *)
energycon = 1.210 × 10^44; (* J/m, c^4/G *)

In[15]:= {massJs, 1 / massJs}

Out[15]= {0.000954774, 1047.37}
```

Some Formulae. Use Kepler to find the separation in au given the period in days. The other two are the “normalized” hzero and omega squared divided by c squared from xxxx
and playing with pretty formatting.

```
In[16]:= Text[Style[
  ToExpression["\\sin\\alpha", TeXForm, HoldForm], Large] ]
```

Out[16]= $\sin\alpha$

In[17]:=
```
Text[Style[ToExpression[
    "h_0 = \\frac{r_{s1}\\ r_{s2}}{r\\cdot R}", TeXForm, HoldForm], Large] ]
```

Out[17]= $$h_0 == \frac{r_{s1}\, r_{s2}}{r \cdot R}$$

In[18]:=
```
Text[Style[ToExpression[
    "{{\\omega_s^2}\\over{c^2}}  = \\frac{r_{s1} + r_{s2}}{2\\ R^3}",
    TeXForm, HoldForm], Large] ]
```

Out[18]= $$\frac{\omega_s^2}{c^2} == \frac{r_{s1}+r_{s2}}{2\, R^3}$$

In[19]:=
```
sepAU[days_] := (days / 365.24) ^ (2 / 3)
(* Test for Null values and return -9999.99 . *)
calchzero[plorbper_, plbmassj_, stmass_, stdist_] :=
 plbmassj * massJs * rscon * stmass * rscon / ( sepAU[plorbper] * au * stdist * pc )
calcωsq[plorbper_, plbmassj_, stmass_] :=
 (plbmassj * massJs + stmass) *
  rscon / 2 / (sepAU[plorbper] * au) ^ 3 (* really (ω/c)^2, like k *)
```

Read the planetsEccOrbPeriod.csv file.

Has 1966 rows starting with # that give the columns and other info. Column headers in Row number 15, then data as strings??

In[22]:=
```
alldata = Import[
   "/scratch/gabella/Documents/astro/exop/planetsEccOrbPeriod2.csv", "Data"];
```

Row 15 has the column headers and Row 12 starts the data. Cols are rowid,pl_hostname,pl_letter,pl_orbper,pl_orbsmax,pl_orbeccen,pl_bmassj,st_dist,st_mass,pl_name,pl_massj

COLUMN pl_hostname: Host Name
COLUMN pl_letter: Planet Letter
COLUMN pl_orbper: Orbital Period [days]
COLUMN pl_orbsmax: Orbit Semi-Major Axis [AU]
COLUMN pl_orbeccen: Eccentricity
COLUMN pl_bmassj: Planet Mass or M*sin(i)[Jupiter mass]
COLUMN st_dist: Distance [pc]
COLUMN st_mass: Stellar Mass [Solar mass]
COLUMN pl_name: Planet Name
COLUMN pl_massj: Planet Mass [Jupiter mass]

In[27]:=
```
rowHeaders = 15; rowDataStart = rowHeaders + 1;
```

In[24]:=
```
alldata[[rowHeaders ;; 20]]
```

Out[24]=
```
{{rowid, pl_hostname, pl_letter, pl_orbper, pl_orbsmax,
  pl_orbeccen, pl_bmassj, st_dist, st_mass, pl_name, pl_massj},
 {1, 11 Com, b, 326.03, 1.29, 0.231, 19.4, 110.62, 2.7, 11 Com b, },
 {2, 11 UMi, b, 516.22, 1.54, 0.08, 10.5, 119.47, 1.8, 11 UMi b, },
 {3, 14 And, b, 185.84, 0.83, 0., 4.8, 76.39, 2.2, 14 And b, },
 {4, 14 Her, b, 1773.4, 2.77, 0.369, 4.64, 18.15, 0.9, 14 Her b, },
 {5, 16 Cyg B, b, 798.5, 1.681, 0.681, 1.68, 21.41, 0.99, 16 Cyg B b, }}
```

In[35]:=
```
{alldata[[rowHeaders]],
  Map[ Head, alldata[[rowDataStart]] ],
  alldata[[77]]} // MatrixForm
```

Out[35]//MatrixForm=

rowid	pl_hostname	pl_letter	pl_orbper	pl_orbsmax	pl_orbeccen	pl_bmassj	st_dist
Integer	String	String	Real	Real	Real	Real	Real
62	CoRoT-11	b	2.99433	0.0436	0.	2.33	560.

Okay it looks like Mathematica treats it as mixed format and guesses pretty well.
Make a dictionary, aka Association in Mathematica, with the header strings to the column numbers / array indices.

In[36]:=
```
rows = <||>; (* Use an Association as an enum, or Dictionary *)
For[icnt = 1, icnt ≤ Length[ alldata[[rowHeaders]] ], icnt += 1,
  AppendTo[rows, alldata[[rowHeaders, icnt]] → icnt]
  (*Print[{alldata[[76,icnt]], icnt}]*)
 ];
```

In[38]:=
```
Keys[rows]
```

Out[38]=
```
{rowid, pl_hostname, pl_letter, pl_orbper, pl_orbsmax,
 pl_orbeccen, pl_bmassj, st_dist, st_mass, pl_name, pl_massj}
```

In[39]:=
```
{rows["rowid"], rows["pl_orbper"]}
```

Out[39]=
```
{1, 4}
```

Plot the period vs eccentricity.

In[40]:=
```
mycols = {"pl_orbper", "pl_orbeccen"}
```

Out[40]=
```
{pl_orbper, pl_orbeccen}
```

Just make a table of a few of the values to check the formatting for plot.

In[41]:=

```
{mycols}~Join~Table[
   Table[
    alldata[[rowHeaders + jj, rows[mycols[[ii]] ] ]], {ii, 1, Length[mycols]}] ,
   {jj, 1, 20 - rowHeaders} (* Length[alldata]-rowHeaders *)
  ] // TableForm (* etc, etc, etc *)
```

Out[41]//TableForm=

pl_orbper	pl_orbeccen
326.03	0.231
516.22	0.08
185.84	0.
1773.4	0.369
798.5	0.681

Plot period vs eccentricity.

```
alldata[[rowDataStart ;; rowDataStart + 3, rows["pl_orbeccen"] ]]
(* First few eccentricities. *)
```

Out[42]= {0.231, 0.08, 0., 0.369}

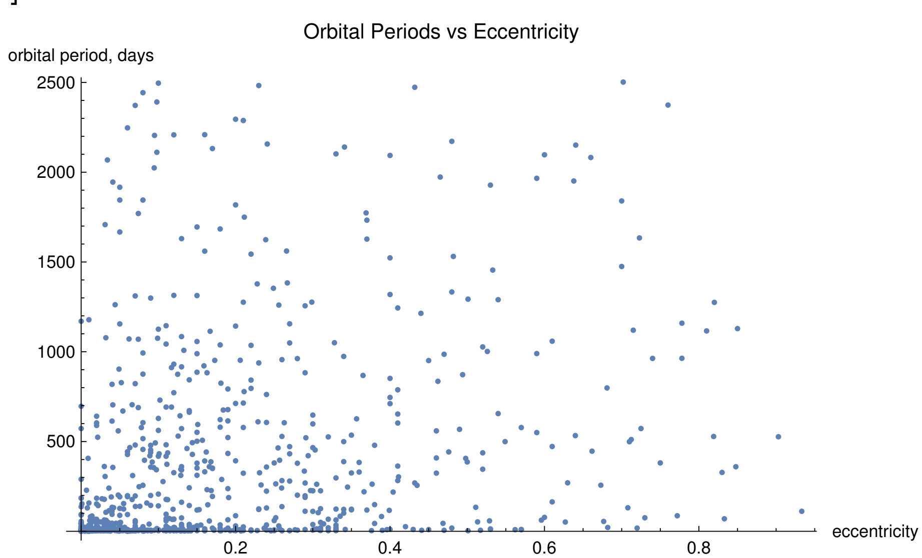
```
Length[ alldata[[rowDataStart ;;, rows["pl_orbeccen"] ]] ]
(* Total number of rows of data, not text header. *)
```

Out[43]= 1966

In[44]:=

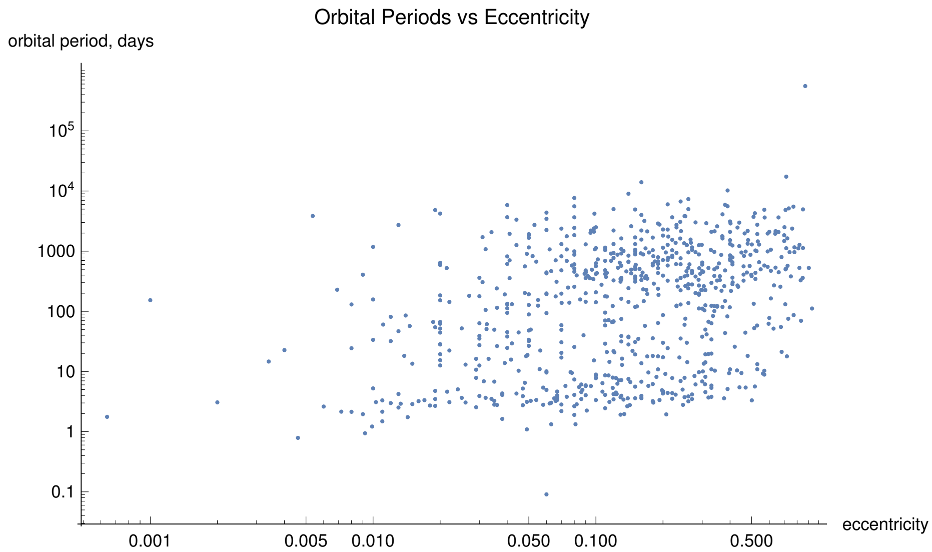
```
ListPlot[ Transpose[{alldata[[rowDataStart ;;, rows["pl_orbeccen"] ]],
   alldata[[rowDataStart ;;, rows["pl_orbper"] ]]}] ,
 PlotLabel → "Orbital Periods vs Eccentricity",
 AxesLabel → {"eccentricity", "orbital period, days"}
]
```

Out[44]=



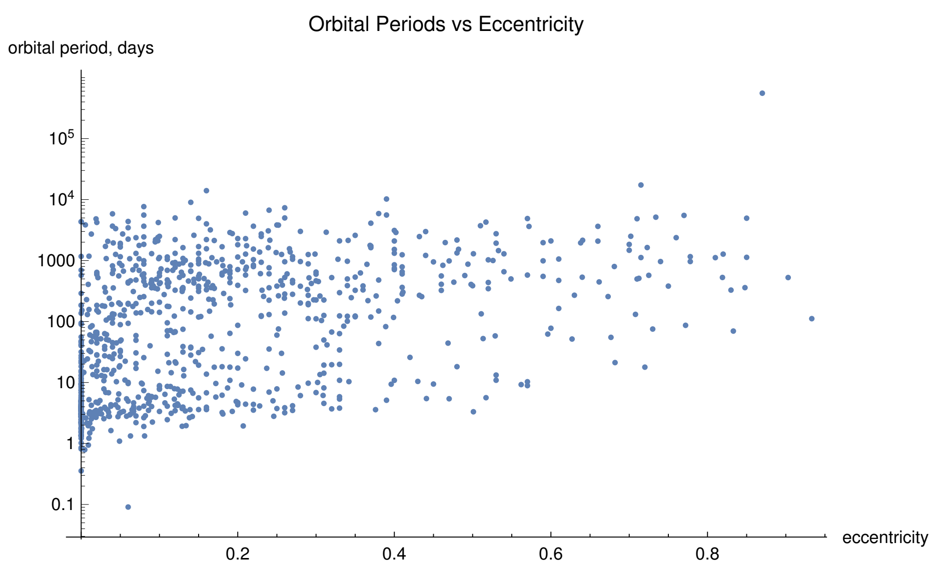
In[45]:=
```
ListLogLogPlot[ Transpose[{alldata[[rowDataStart ;;, rows["pl_orbeccen"] ]],
    alldata[[rowDataStart ;;, rows["pl_orbper"] ]]}] ,
 PlotLabel → "Orbital Periods vs Eccentricity",
 AxesLabel → {"eccentricity", "orbital period, days"}
]
```

Out[45]=



In[46]:=
```
ListLogPlot[ Transpose[{alldata[[rowDataStart ;;, rows["pl_orbeccen"] ]],
    alldata[[rowDataStart ;;, rows["pl_orbper"] ]]}] ,
 PlotLabel → "Orbital Periods vs Eccentricity",
 AxesLabel → {"eccentricity", "orbital period, days"}
]
```

Out[46]=



Find the maximum eccentricity and the minimum and maximum of the orbital period.

In[63]:=
```
{alldata[[rowDataStart + 9, rows["pl_orbeccen"]]],
 Head[ alldata[[rowDataStart + 9, rows["pl_orbeccen"]]]],
 NumberQ[alldata[[rowDataStart + 9, rows["pl_orbeccen"]]]]}
```
Out[63]=
```
{, String, False}
```
In[64]:=
```
{alldata[[rowDataStart, rows["pl_orbeccen"]]],
 Head[ alldata[[rowDataStart + 9, rows["pl_orbeccen"]]]],
 NumberQ[alldata[[rowDataStart + 9, rows["pl_orbeccen"]]]]}
```
Out[64]=
```
{0.231, String, False}
```
In[98]:=
```
(* Trouble becasue the blanks are treated as strings ! *)
ecclist = ToExpression@ alldata[[rowDataStart ;;, rows["pl_orbeccen"]]];
```
In[111]:=
```
ecclist[[12 ;; 15]]
Map[NumberQ, ecclist[[12 ;; 15]]]
```
Out[111]=
```
{Null, Null, Null, 0.26}
```
Out[112]=
```
{False, False, False, True}
```
In[117]:=
```
Clear["filterBlanks"]
filterBlanks[aa_] := Module[{retList},
   retList = {};
   For[i = 1, i <= Length[aa], i ++,
    If[ NumberQ[ aa[[i]]], AppendTo[retList, aa[[i]]], ]
   ];
   retList
  ]
```
In[115]:=
```
?? filterBlanks
```
```
Global`filterBlanks

filterBlanks[aa_] := Module[{retList}, retList = {};
  For[i = 1, i ≤ Length[aa], i ++,
    If[NumberQ[aa⟦i⟧], AppendTo[retList, aa⟦i⟧], Null]] retList]
```
In[120]:=
```
ecclistFilt = filterBlanks[ecclist]; ecclistFilt[[12 ;; 15]]
```
Out[120]=
```
{0.38, 0.032, 0.098, 0.16}
```
```
{Max[ ecclistFilt ], Min[ecclistFilt]} (* eccentricity 0 to 1 *)
```
Out[122]=
```
{0.9332, 0.}
```
```
{Max[ filterBlanks[alldata[[rowDataStart ;;, rows["pl_orbper"]]] ]], Min[
  filterBlanks[ alldata[[rowDataStart ;;, rows["pl_orbper"]]] ]]} (* in days *)
```
Out[123]=
$\{7.3\times10^{6},\ 0.0907063\}$

Periods in secs, and Frequencies in Hz

In[126]:=
```
somePers = {1, 10., 100., 1000., 10 000.} * 24.0 * 3600. (* Periods in seconds. *)
Divide[{1., 1., 1., 1., 1}, somePers] (* Freqencies in Hz. *)
```

Out[126]= $\{86\,400., 864\,000., 8.64\times10^{6}, 8.64\times10^{7}, 8.64\times10^{8}\}$

Out[127]= $\{0.0000115741, 1.15741\times10^{-6}, 1.15741\times10^{-7}, 1.15741\times10^{-8}, 1.15741\times10^{-9}\}$

Formulae for the frequencies of GW from eccentric orbits.
Peters and Mathew 1963, but really using Maggiore page 184.

In[51]:=
```
(* Can Mathematica use underscores yet? Nope, the underscore should
 be used only to designate the type when dummy function vars. *)
(*aa_bb=23
   aa_bb+=2 Error *)
```

In[128]:=
```
?? BesselJ
```

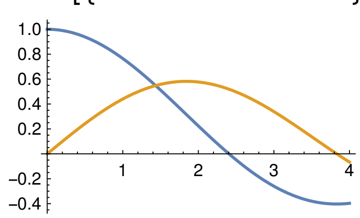
BesselJ[n, z] gives the Bessel function of the first kind $J_n(z)$. ≫

Attributes[BesselJ] = {Listable, NumericFunction, Protected, ReadProtected}

Eqns. 4.94-95, small a_n and small b_n . Fourier coefficients for x(t) and y(t), all orbital motion in the x-y plane.

In[140]:=
```
jj = BesselJ[#1, #2] &;
sma[n_, e_, asmaj_] := asmaj/n (jj[n - 1, n * e] - jj[n + 1, ne])
(* n-freq mult/index, e-ecc, asmaj-semimajor axis *)
smb[n_, e_, asmaj_] := asmaj/n (jj[n - 1, n * e] - jj[n + 1, ne])
```

In[136]:=
```
(* check the jj defn *)
Plot[{jj[0, u], jj[1, u]}, {u, 0, 4}]
```

Out[136]=


Eqns. 4.99-101

In[156]:=
```
bigA[n_, e_, asmaj_] :=
  asmaj^2/n (jj[n - 2, n e] - jj[n + 2, n e] - 2 e jj[n - 1, n e] + 2 e jj[n + 1, n e] )
bigB[n_, e_, asmaj_] := (asmaj^2 (1 - e^2))/n (jj[n + 2, n e] - jj[n - 2, n e])
bigC[n_, e_, asmaj_] :=
  (asmaj^2 Sqrt[1 - e^2])/n (jj[n + 2, n e] + jj[n - 2, n e] - e jj[n + 1, n e] - e jj[n - 1, n e] )
gg[n_, e_, asmaj_] := n^6/(96 asmaj^4) (bigA[n, e, asmaj]^2 + bigB[n, e, asmaj]^2 +
    3 bigC[n, e, asmaj]^2 - bigA[n, e, asmaj] * bigB[n, e, asmaj])
```

Check some limits, like e->0.

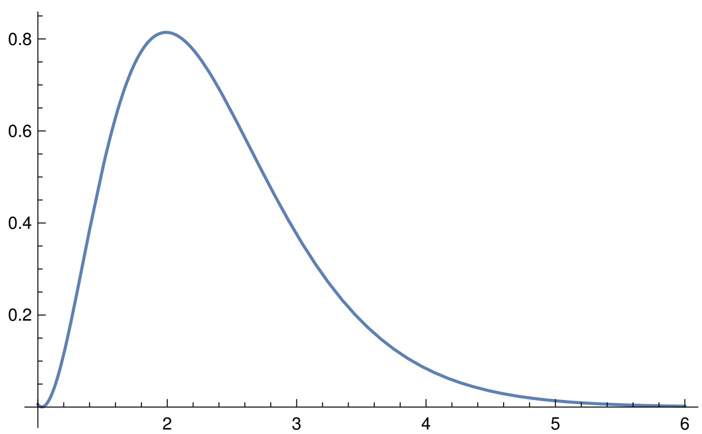
In[164]:=
```
{gg[2, 0, 1], gg[1, 0.2, 1], gg[1, 0.8, 1]}
```

Out[164]= {1, 0.00579633, 0.0430687}

Plot Maggiore Fig. 4.8 (maybe), they are normalized to P for e=0 but what a? Try a=1.

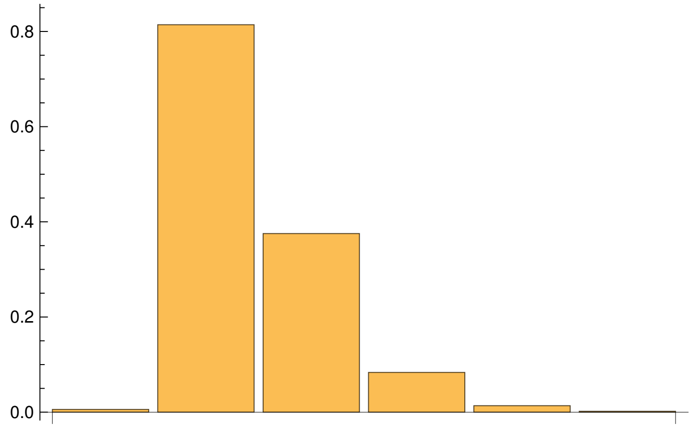
In[166]:=
```
aplot = Plot[gg[n, 0.2, 1.0] / gg[2, 0, 1], {n, 1, 6}]
```

Out[166]=



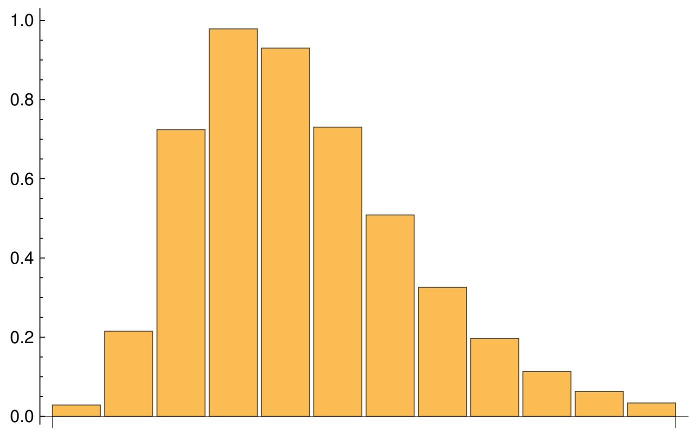
In[168]:=
```
BarChart[ Table[
  gg[n, 0.2, 1.0] / gg[2, 0, 1], {n, 1, 6}
 ]]
```

Out[168]=



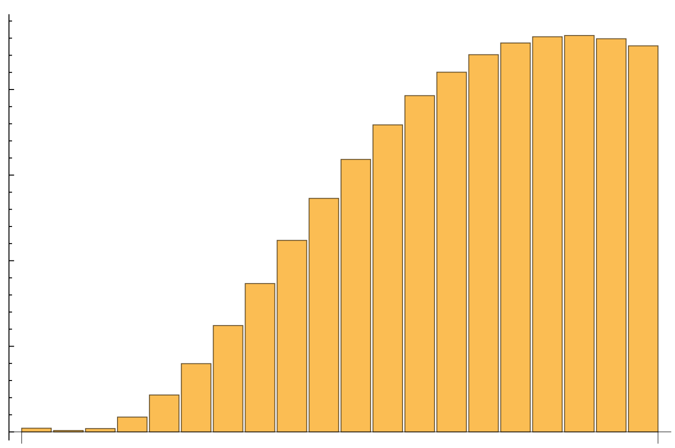
In[171]:=
```
BarChart[ Table[
  gg[n, 0.5, 1.0] / gg[2, 0, 1], {n, 1, 12}
 ]]
```

Out[171]=



In[172]:=
```
BarChart[ Table[
  gg[n, 0.8, 1.0] / gg[2, 0, 1], {n, 1, 20}
 ]]
```

Out[172]=



Found masses for HIP 79431 st_mass is 0.49 (Wikipedia), and for HR 810 about 1.25 from http://www.-solstation.com/stars2/iotahoro.htm .

In[52]:=
```
{alldata[[76 + 7, rows["pl_hostname"]]], alldata[[76 + 7, rows["st_mass"]]]}
alldata[[76 + 7, rows["st_mass"]]] = 0.49
```

Out[52]= {CoRoT-22, 1.1}

Out[53]= 0.49

In[54]:=
```
{alldata[[76 + 8, rows["pl_hostname"]]], alldata[[76 + 8, rows["st_mass"]]]}
alldata[[76 + 8, rows["st_mass"]]] = 1.25
```

Out[54]= {CoRoT-23, 1.14}

Out[55]= 1.25

In[56]:=
```
mytable = { mycols~Join~{ "hzero,1e-24", "freq, Hz"} }~Join~
   Table[
    Table[
      alldata[[76 + jj, rows[mycols[[ii]] ] ]], {ii, 1, Length[mycols]}]~Join~
     {10^24 * calchzero[ alldata[[76 + jj, rows["pl_orbper" ] ]],
        alldata[[76 + jj, rows["pl_bmassj" ] ]],
        alldata[[76 + jj, rows["st_mass" ] ]],
        alldata[[76 + jj, rows["st_dist" ] ]]   ] ,
      2 * cee / (2 * Pi) * Sqrt[ calcωsq[ alldata[[76 + jj, rows["pl_orbper" ] ]],
         alldata[[76 + jj, rows["pl_bmassj" ] ]],
         alldata[[76 + jj, rows["st_mass" ] ]] ] ]
     },
    {jj, 1, Length[alldata] - 76}
   ] // TableForm
```

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. ≫

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. ≫

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. ≫

General::stop : Further output of Part::pkspec1 will be suppressed during this calculation. ≫

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. ≫

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. ≫

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. ≫

General::stop : Further output of Part::pkspec1 will be suppressed during this calculation. ≫

Out[56]//TableForm=

… 1 …

large output | show less | show more | show all | set size limit...

In[57]:=
```
Export["/scratch/gabella/Documents/astro/exop/closeJules.csv", mytable, "CSV"]
```

Out[57]=
```
$Aborted
```

```
(* mycols~Join~{ ,"freq, Hz" "hzero,1e-24"}  }~Join~
                   and "hf (1mos)" and "hf (6mos)"
*)
oneMos = 2.592 × 10^6; (* 30 days in seconds *)
halfYear = 1.578 × 10^7;(* half year in seconds *)
oneYear = 365.24 * 24 * 3600.; (* one year in seconds *)
newdata = Module[{ahzero, bb},
  Table[
   Table[
     alldata[[76 + jj, rows[mycols[[ii]] ]]], {ii, 1, Length[mycols]}] ~Join~
    {
     2 * cee / (2 * Pi) * Sqrt[ calcωsq[ alldata[[76 + jj, rows["pl_orbper" ] ]],
         alldata[[76 + jj, rows["pl_bmassj" ] ]],
         alldata[[76 + jj, rows["st_mass" ] ]] ] ] ,
     ahzero = 10^24 * calchzero[ alldata[[76 + jj, rows["pl_orbper" ] ]],
         alldata[[76 + jj, rows["pl_bmassj" ] ]],
         alldata[[76 + jj, rows["st_mass" ] ]],
         alldata[[76 + jj, rows["st_dist" ] ]]  ] ,
     ahzero * Sqrt[3 * oneYear] * 10^-24,
     ahzero * Sqrt[5 * oneYear] * 10^-24,
     ahzero * Sqrt[10 * oneYear] * 10^-24
    },
   {jj, 1, Length[alldata] - 76}
  ]
 ]
```

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. >>

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. >>

Part::pkspec1 : The expression Missing[KeyAbsent, st_dist] cannot be used as a part specification. >>

General::stop : Further output of Part::pkspec1 will be suppressed during this calculation. >>

```
$Aborted[]
```

```
btable =
 {mycols~Join~{"freq, Hz", "hzero,1e-24", "hf, 3yr", "hf, 5yr", "hf, 10yr"} }~
   Join~newdata // TableForm
```

rowid	pl_hostname	pl_orbper	pl_bmassj	st_dist	st_mass	freq, Hz
340	HD 160691	643.25	1.08	15.28	1.08	3.74271×10^{-8}
312	HD 147513	528.4	1.21	12.87	1.11	4.61925×10^{-8}
439	HD 217107	7.12682	1.39	19.72	1.02	3.28347×10^{-6}
472	HD 27442	428.1	1.56	18.24	1.23	6.00229×10^{-8}
1947	gam Cep	903.3	1.85	13.79	1.4	3.03496×10^{-8}
1960	ups And	241.258	1.981	13.47	1.3	1.0951×10^{-7}
646	HIP 79431	111.7	2.1	14.9	0.49	1.45405×10^{-7}
651	HR 810	312.	2.13	17.24	1.25	8.30425×10^{-8}
130	GJ 876	61.1166	2.2756	4.7	0.33	2.18358×10^{-7}
548	HD 62509	589.64	2.3	10.34	2.1	5.69372×10^{-8}
33	7 CMa	796.	2.46	19.84	1.52	3.58914×10^{-8}
102	GJ 317	692.	2.5	15.1	0.42	2.17468×10^{-8}
101	GJ 3021	133.71	3.37	17.62	0.9	1.64581×10^{-7}
129	GJ 86	15.7649	3.91	10.91	0.77	1.29197×10^{-6}
1957	tau Boo	3.31246	4.32	15.6	1.34	8.10432×10^{-6}
360	HD 1690	533.	6.1	7.01	1.09	4.54768×10^{-8}
34	70 Vir	116.693	7.4	18.11	1.09	2.07836×10^{-7}

```
Export["/scratch/gabella/Documents/astro/exop/closeJulesHfYrs.csv", btable, "CSV"]
```

/scratch/gabella/Documents/astro/exop/closeJulesHfYrs.csv

```
{newdata[[1]], newdata[[2]]} // TableForm
```

340	HD 160691	643.25	1.08	15.28	1.08	3.74271×10^{-8}	0.0945518	9.[illegible]
312	HD 147513	528.4	1.21	12.87	1.11	4.61925×10^{-8}	0.147374	1.[illegible]

The hf for Tobs = 3 years.

```
atab = Table[{newdata[[ii, 7]], newdata[[ii, 9]]}, {ii, 1, Length[newdata]}]
```

$\{\{3.74271\times10^{-8}, 9.19976\times10^{-22}\}, \{4.61925\times10^{-8}, 1.43393\times10^{-21}\}, \{3.28347\times10^{-6}, 1.74348\times10^{-20}\}, \{6.00229\times10^{-8}, 1.66321\times10^{-21}\}, \{3.03496\times10^{-8}, 1.80504\times10^{-21}\}, \{1.0951\times10^{-7}, 4.43042\times10^{-21}\}, \{1.45405\times10^{-7}, 2.67403\times10^{-21}\}, \{8.30425\times10^{-8}, 3.015\times10^{-21}\}, \{2.18358\times10^{-7}, 9.24793\times10^{-21}\}, \{5.69372\times10^{-8}, 5.96587\times10^{-21}\}, \{3.58914\times10^{-8}, 1.97061\times10^{-21}\}, \{2.17468\times10^{-8}, 7.98204\times10^{-22}\}, \{1.64581\times10^{-7}, 5.91193\times10^{-21}\}, \{1.29197\times10^{-6}, 3.94173\times10^{-20}\}, \{8.10432\times10^{-6}, 1.49969\times10^{-19}\}, \{4.54768\times10^{-8}, 1.29576\times10^{-20}\}, \{2.07836\times10^{-7}, 1.67501\times10^{-20}\}\}$

```
Export["/scratch/gabella/Documents/astro/exop/threeYears.dat", atab]
```

/scratch/gabella/Documents/astro/exop/threeYears.dat

```
btab = Table[{newdata[[ii, 7]], newdata[[ii, 10]]}, {ii, 1, Length[newdata]}]
```

$\{\{3.74271\times10^{-8}, 1.18768\times10^{-21}\},$
$\{4.61925\times10^{-8}, 1.85119\times10^{-21}\}, \{3.28347\times10^{-6}, 2.25082\times10^{-20}\},$
$\{6.00229\times10^{-8}, 2.14719\times10^{-21}\}, \{3.03496\times10^{-8}, 2.33029\times10^{-21}\},$
$\{1.0951\times10^{-7}, 5.71964\times10^{-21}\}, \{1.45405\times10^{-7}, 3.45215\times10^{-21}\},$
$\{8.30425\times10^{-8}, 3.89235\times10^{-21}\}, \{2.18358\times10^{-7}, 1.1939\times10^{-20}\},$
$\{5.69372\times10^{-8}, 7.70191\times10^{-21}\}, \{3.58914\times10^{-8}, 2.54404\times10^{-21}\},$
$\{2.17468\times10^{-8}, 1.03048\times10^{-21}\}, \{1.64581\times10^{-7}, 7.63227\times10^{-21}\},$
$\{1.29197\times10^{-6}, 5.08875\times10^{-20}\}, \{8.10432\times10^{-6}, 1.9361\times10^{-19}\},$
$\{4.54768\times10^{-8}, 1.67282\times10^{-20}\}, \{2.07836\times10^{-7}, 2.16242\times10^{-20}\}\}$

```
Export["/scratch/gabella/Documents/astro/exop/fiveYears.dat", btab]
```

/scratch/gabella/Documents/astro/exop/fiveYears.dat

```
btab = Table[{newdata[[ii, 7]], newdata[[ii, 11]]}, {ii, 1, Length[newdata]}]
Export["/scratch/gabella/Documents/astro/exop/tenYears.dat", btab]
```

$\{\{3.74271\times10^{-8}, 1.67964\times10^{-21}\},$
$\{4.61925\times10^{-8}, 2.61798\times10^{-21}\}, \{3.28347\times10^{-6}, 3.18314\times10^{-20}\},$
$\{6.00229\times10^{-8}, 3.03659\times10^{-21}\}, \{3.03496\times10^{-8}, 3.29553\times10^{-21}\},$
$\{1.0951\times10^{-7}, 8.08879\times10^{-21}\}, \{1.45405\times10^{-7}, 4.88208\times10^{-21}\},$
$\{8.30425\times10^{-8}, 5.50462\times10^{-21}\}, \{2.18358\times10^{-7}, 1.68843\times10^{-20}\},$
$\{5.69372\times10^{-8}, 1.08921\times10^{-20}\}, \{3.58914\times10^{-8}, 3.59782\times10^{-21}\},$
$\{2.17468\times10^{-8}, 1.45731\times10^{-21}\}, \{1.64581\times10^{-7}, 1.07937\times10^{-20}\},$
$\{1.29197\times10^{-6}, 7.19658\times10^{-20}\}, \{8.10432\times10^{-6}, 2.73805\times10^{-19}\},$
$\{4.54768\times10^{-8}, 2.36573\times10^{-20}\}, \{2.07836\times10^{-7}, 3.05813\times10^{-20}\}\}$

/scratch/gabella/Documents/astro/exop/tenYears.dat

Look at eccentricities

```
AppendTo[mycols, "pl_orbeccen"]
```

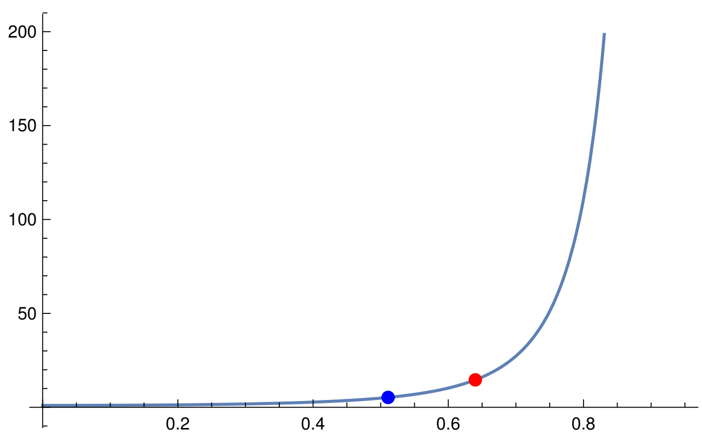
{rowid, pl_hostname, pl_orbper, pl_bmassj, st_dist, st_mass, pl_orbeccen}

```
{mycols}~Join~Table[
   Table[
    alldata[[76 + jj, rows[mycols[[ii]] ] ]], {ii, 1, Length[mycols]}],
   {jj, 1, Length[alldata] - 76}
  ] // TableForm
```

rowid	pl_hostname	pl_orbper	pl_bmassj	st_dist	st_mass	pl_orbeccen
340	HD 160691	643.25	1.08	15.28	1.08	0.128
312	HD 147513	528.4	1.21	12.87	1.11	0.26
439	HD 217107	7.12682	1.39	19.72	1.02	0.1267
472	HD 27442	428.1	1.56	18.24	1.23	0.06
1947	gam Cep	903.3	1.85	13.79	1.4	0.049
1960	ups And	241.258	1.981	13.47	1.3	0.2596
646	HIP 79431	111.7	2.1	14.9	0.49	0.29
651	HR 810	312.	2.13	17.24	1.25	0.15
130	GJ 876	61.1166	2.2756	4.7	0.33	0.0324
548	HD 62509	589.64	2.3	10.34	2.1	0.02
33	7 CMa	796.	2.46	19.84	1.52	0.22
102	GJ 317	692.	2.5	15.1	0.42	0.11
101	GJ 3021	133.71	3.37	17.62	0.9	0.511
129	GJ 86	15.7649	3.91	10.91	0.77	0.0416
1957	tau Boo	3.31246	4.32	15.6	1.34	0.011
360	HD 1690	533.	6.1	7.01	1.09	0.64
34	70 Vir	116.693	7.4	18.11	1.09	0.399

$$\text{bigF[e\_] :=} \frac{\left(1 + \frac{73}{24} e^2 + \frac{37}{96} e^4\right)}{\left(1 - e^2\right)^{7/2}}$$

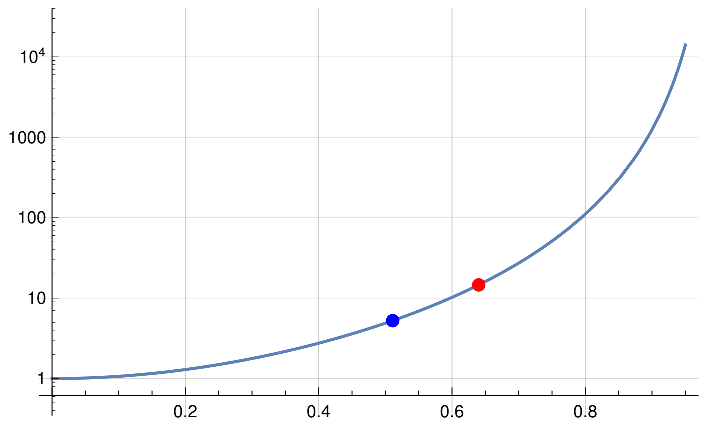
```
Show[
 Plot[bigF[e], {e, 0, 0.95}],
 Graphics[{PointSize[Large], Red, Point[{0.64, bigF[0.64]}]}],
 Graphics[{PointSize[Large], Blue, Point[{0.511, bigF[0.511]}]}]
]
```




```
{bigF[0.64], bigF[0.511]}
```

{14.6116, 5.25036}

```
Show[
 LogPlot[bigF[e], {e, 0, 0.95}, GridLines → Automatic],
 Graphics[{PointSize[Large], Red, Point[{0.64, Log[bigF[0.64]]}]}],
 Graphics[{PointSize[Large], Blue, Point[{0.511, Log[bigF[0.511]]}]}]
]
```




```
Solve[bigF[u] == 100.0, {u}]
```

```
{{u → -1.04567 - 0.199658 i}, {u → -1.04567 + 0.199658 i}, {u → -0.793955},
 {u → 0.793955}, {u → 1.04567 - 0.199658 i}, {u → 1.04567 + 0.199658 i}}
```

```
Log[2.7818]
```

```
1.0231
```

```
10^5.2
```

```
158489.
```