Feasibility of a Dyson ring

(code)

Orbit of collectors;

Constants;

In[1]:=

```
G =  6.67 × 10^-11; (* Universal gravitational constant *)
Ms = 1.988435 × 10^30; (* Mass of the Sun *)
Rs  = 6.957 × 10^8;(* Average solar radii measured upto the photosphere *)
r = 6 × 10^6; (* radius of Sun *)
c  = 3 × 10^8; (* Speed of light *)

v[y_] := N[Sqrt[G Ms / y]];  (* orbital velocity of a collector *)
v1 = v[Input["Radius", 60 Rs]];
v2 = v[Input["Radius", 215 Rs]];
ar  = (v1 / c) 10; (* animation rate *)

Print["The orbital velocity of collectors at distance 60Rs: ", v1 " m/s \n"]
Print["The orbital velocity of collectors at distance 1 AU: ", v2 " m/s \n"]
Print["The animation rate is: ", ar]
```

*The orbital velocity of collectors at distance 60*R_s*:* 56 367.9174 m/s

The orbital velocity of collectors at distance 1 AU: 29 777.5104 m/s

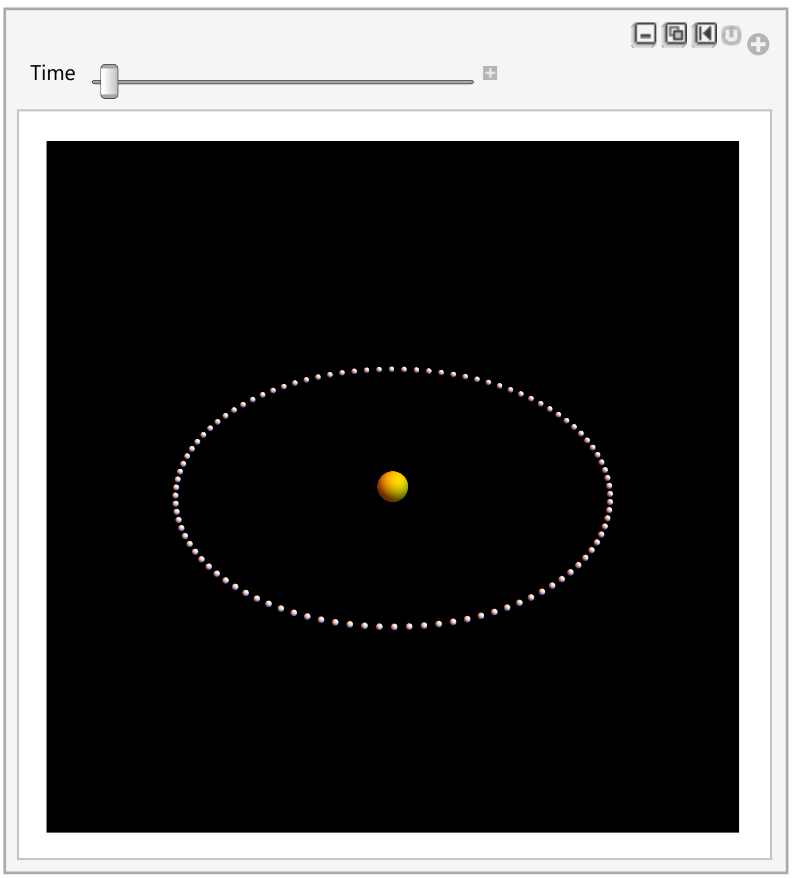
The animation rate is: 0.00187893058

In[2]:=

Simulating the orbital motion of SPCSs around sun;

```
u = Input["Number of satellites", 100];
v2 = a_r;

fo[j_, t_, k_] :=
 {White, Sphere[{.7 Cos[t + ((j 2 Pi) / k)], .7 Sin[t + ((j 2 Pi) / k)], 0}, .01]}
(* positions of satellites in the orbit *)

DR = Manipulate[Graphics3D[{{Style[Sphere[{0, 0, 0}, 0.05], Hue[1.145]]},
    {FaceForm[], Sphere[{0, 0, 0}, 0.9] (* orbit *)},
    Black, Table[Line[
      Table[{0.8}[[i]] {Cos[tt], Sin[tt], 0}, {tt, 0, 2 Pi, 2 Pi / 100}]], {i, 1}],
    Table[fo[j, t, u], {j, 0, u, 1}]},
   PlotRange → All, Boxed → False, SphericalRegion → True,
   ViewAngle → 20 °, Background → Black, BoxRatios → Automatic],
  {{t, 0, "Time"}, 0, 2 π, AnimationRate → v2}, AppearanceElements → All]
```

Out[46]=



In[7]:=

```
θ = (2 Pi)/u; (* angular separaion between collectors *)
dc = 60 Rs θ ;(* distance between collectors *)

Print["The angular separation between two collectors is: ", N[θ], " rads\n"]
Print["The distance between any two collectors is: ", dc, " m\n"]
```

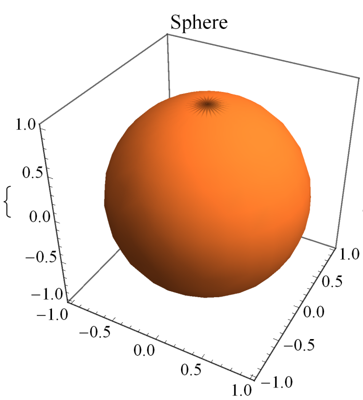
The angular separation between two collectors is: 0.0628318531 rads

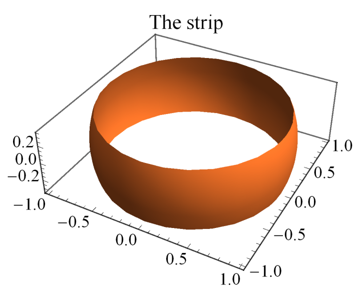
The distance between any two collectors is: 2.62272721×10^9 m

In[11]:=

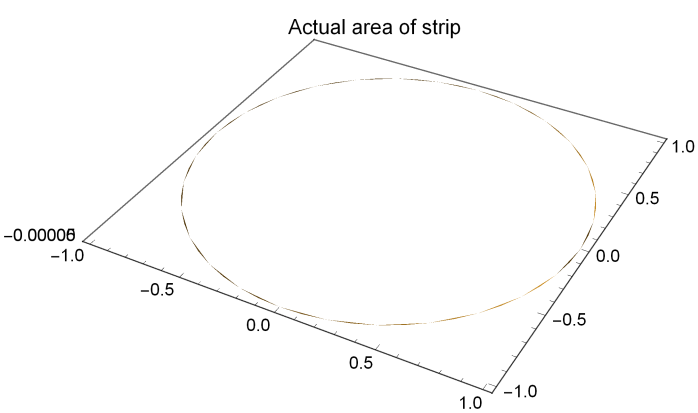
Luminosity calculations;

```
{RevolutionPlot3D[{Cos[t], Sin[t]}, {t, 0, 2 Pi}, PlotTheme → "Scientific",
   ColorFunction → Hue[0.13, 0.9, 0.94, 0.89], Mesh → None, PlotLabel → "Sphere"]
  (* total surface area of the Sun *),

 RevolutionPlot3D[{Cos[v], Sin[v]}, {v, -Pi/9, Pi/9}, PlotTheme → "Scientific",
   ColorFunction → Hue[0.7, 1., 0.78], Mesh → None, PlotLabel → "The strip"]
   (* surface of Sun which contributes to maximum
   incident radition i.e. the area of strip *)}



ang[k_] := 2 ArcTan[k/r];
w = ang[10000] Pi/180 // N; (* actual calculation of height of strip *)
RevolutionPlot3D[{Cos[v], Sin[v]}, {v, -w, w}, Mesh → None,
 ColorFunction → Black, Mesh → None, PlotLabel → "Actual area of strip"]
```

Out[12]= {

, 

}

Out[15]= 

In[16]:=

```
Lsun = Print["\nLuminosity of Sun is: ", 3.848 × 10^26, " W\n"]
Ls = 3.848 × 10^26;(* solar luminosity *)
Is = Ls/(4 Pi (60 Rs)^2) (* irradiance in W/m^2 *);
Print["Irradiance at a distance 60Rs: ", Is, " W/m^2"]
```

Luminosity of Sun is: 3.848×10^{26} W

Irradiance at a distance 60R_s: 17574.3266 W/m^2

In[20]:=

```
ar[d_] := N[4 Pi r^2 (1 - Cos[ArcTan[d/√(r^2 - d^2)]])]; (* area of strip *)

a1 = ar[Input["Enter projected height of strip: ", 10000]];
area = Print["\nThe area of radiating strip is: ", a1, " m^2 \n"]
a3 = N[Pi (Rs)^2]; (* surface area of sun *)

LumR = (a1 Ls)/a3; (* Luminosity of the strip *)
LumS = Print["The luminosity of strip is: ", LumR, " W"]
```

The area of radiating strip is: 6.28318967×10^{8} m^2

The luminosity of strip is: 1.59008871×10^{17} W

In[26]:=

Power generated;

```
n1 = Input["Number of arrays per satellite", 10];
A = n1 312 ; (* area of a solar array of single satellite in sq. m *)
at = u A ;(* total area of system in m^2*)
u1 = u;
Ps = 1400; (* avg solar power density in w/sq. m *)


eff = {0.2, 0.5};
(* 0.2 for ordinary silicon PV cell,
0.5 for two-step photon conversion based PV cells *)
Prec = N[I_s at]; (* power received *)
Pgen =  N[eff Prec]; (* power output *)
Pgen1 = Pgen // TableForm;
Pe = 0.2 × 10^12 (* in watts *);


avc = 2 × 10^9; (* cost of Parker mission  in $ *)
cost[d_] := avc d;
mcos = cost[u1];
Print["\nEnergy density in upper atmosphere of earth: ",
 Ps, " W/m^2 \n", "\nEnergy density at a distance 60R_s: ", I_s,
 " W/m^2 \n\n",  "Total area of system: ", at, " m^2 \n\n",
 "Power generated: ", Pgen1, " W\n\n", "Mission cost: $", N[mcos]]
```

Energy density in upper atmosphere of earth: 1400 W/m^2

Energy density at a distance $60R_s$: 17 574.3266 W/m^2

Total area of system: 312 000 m^2

Power generated: $\begin{matrix} 1.09663798 \times 10^9 \\ 2.74159494 \times 10^9 \end{matrix}$ W

Mission cost: $2. × 10^{11}

In[41]:=

Power incurred;

```
le = 0.7; (* maximum efficiency of diode laser system*)

Pinc = le Pgen;
Pinc1 = Pinc // TableForm;

Print["\nPower Incurred: ", Pinc1, " W\n\n"]
```

Power Incurred: $\begin{array}{l} 7.67646584\times10^{8} \\ 1.91911646\times10^{9} \end{array}$ W