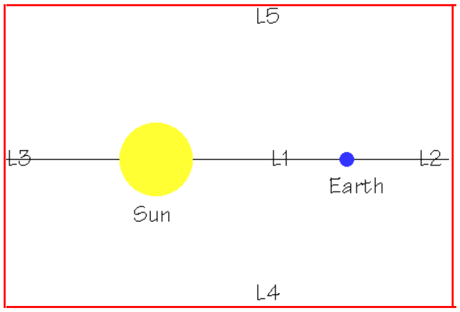

L2 Natural Environment Summary

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Purpose: This paper is intended to summarize the environment that exists at L2 and/or in orbits around L2.

Executive Summary:

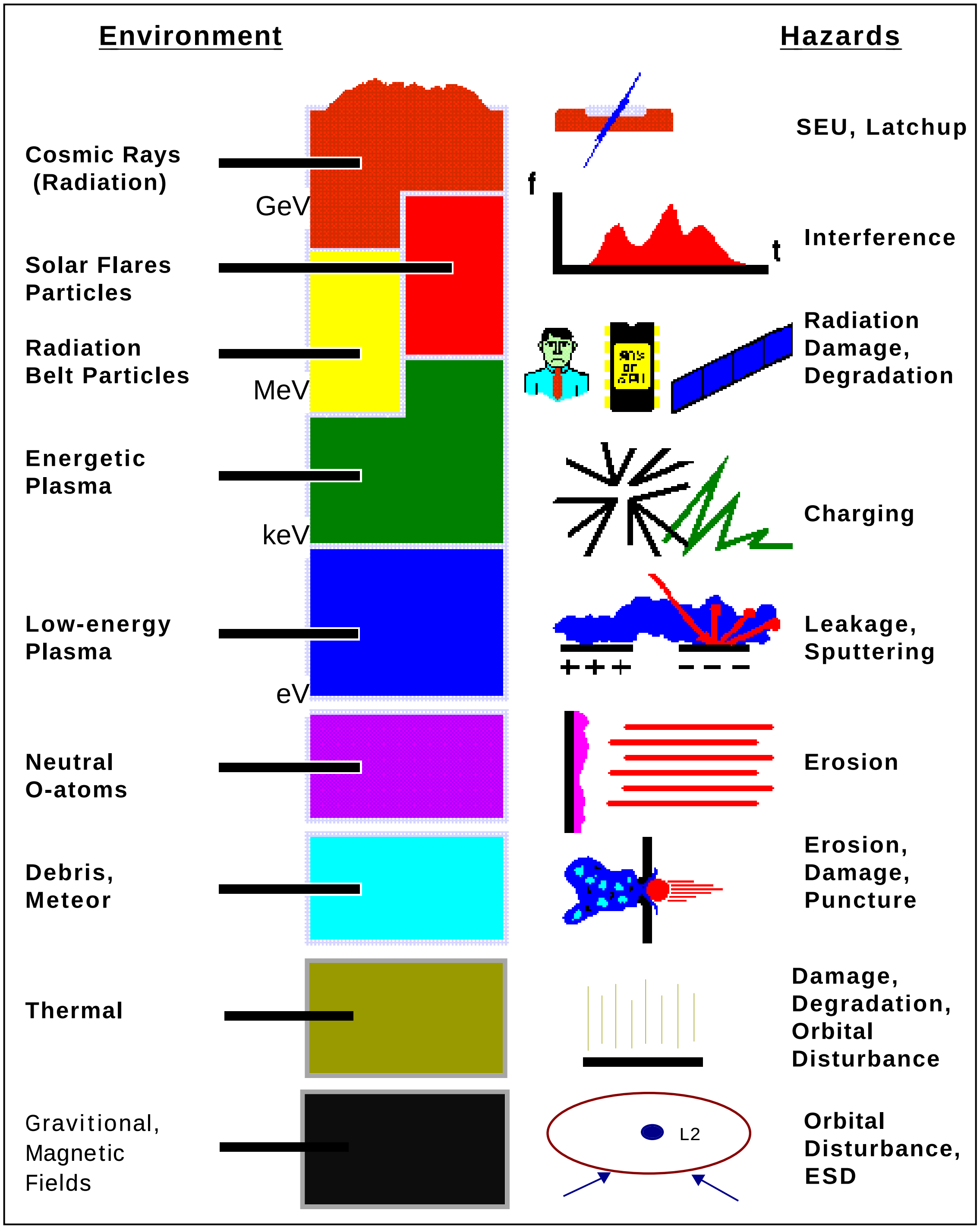
The natural environment at any point in space can be any combination of eight environmental contribution mechanisms (neutral thermosphere, thermal, plasma, meteoroids & orbital debris, solar, ionizing radiation, magnetic & gravitational fields (See Figure 1)). The L2 point's environment consists of a combination of thermal, plasma, meteoroids, solar, ionizing radiation, magnetic field, and gravitational field mechanisms. The magnitude of each of these environmental mechanisms at L2 is detailed in this paper, thereby enabling more effective designing and planning for future L2 spacecraft missions.

The L2 natural environment and the environment of the orbits around that point as quantified in this paper are relatively benign compared to those of Geosynchronous and Low-Earth orbits. The effects of the effective environmental mechanisms will still need to be factored in to the design of spacecraft intended to operate at these locations. Specifically, the following design considerations and trades will have to be analyzed based on spacecraft performance requirements:

- Thermal Protection and Control
- Charge Build-up Potential
- Material and Surface Penetration Potential
- Orbital and Attitude Disturbance and Control
- Noise Source Mitigation
- Radiation Shielding
- Launch/Trajectory Planning.

In addition to considering the L2 natural environmental impacts to a design, the impact of the environments encountered in the candidate trajectories to L2 and the orbits around it must also be quantified and factored into spacecraft/observatory design decisions. However, trajectory environments vary with respect to the trajectory planned and are therefore a programmatic variable. Therefore further analyses must be done on a program-by-program basis for those programs (i.e., MAP, NGST) that will go to the L2 point or orbit it to assess the full (operational and trajectory) environmental impact on their preliminary design to arrive at a final design that will achieve a safe and successful mission.

Figure 1: Environmental Hazards Summary



L2 Environmental Details:

The natural environment at any point in space can be any combination of eight environmental contribution mechanisms (neutral thermosphere, thermal, plasma, meteoroids & orbital debris, solar, ionizing radiation, magnetic & gravitational fields (See Figure1)). The L2 point's environment consists of a combination of thermal, plasma, meteoroids, solar, ionizing radiation, magnetic field, and gravitational field mechanisms. The magnitude of each of these environmental mechanisms at L2 is detailed in the following sections, thereby enabling more effective designing and planning for future L2 spacecraft missions.

Neutral Thermosphere:

The Neutral Thermosphere is the portion of the Earth's atmosphere between 90km and 600km which due its' thermal characteristics tends to stratify neutral gases based on their molecular weight. Atomic Oxygen is the dominant constituent in the lower thermosphere while helium and hydrogen dominate the higher regions. Many materials used on spacecraft are susceptible to atomic oxygen erosion but since the L2 point (1.5 $X10^6$km from the center of the Earth (COE)) is not within the Earth's Neutral Thermosphere this environmental mechanism does not apply to L2 or the orbits around it.

Thermal:

In space thermal energy comes from three major sources, incoming solar radiation, reflected solar energy (albedo), and outgoing long-wave radiation from the Earth. The L2 point is at such a distance (1.5 $X10^6$km from the COE) from the Earth that the only type of thermal energy for to affect the region is the incoming solar radiation with a solar constant for heating of 1291-1421W/m^2[NGST 1998]. Therefore thermal energy is an applicable environmental mechanism at L2 and the orbits around it.

Plasma:

A plasma is a quasi-neutral gas of charged and neutral particles that act collectively and represent a surface charging risk to spacecraft. In space, plasma extends from the ionosphere of the Earth to the far reaches of the solar system and encompasses plasmas of many different compositions, densities, and risk potentials. The plasma found at L2 and the orbits around L2 is that contained in solar wind. Solar wind plasma is essentially a neutral or cold plasma. Specifically, this plasma will have the following characteristics at L2 and the orbits around it:

Composition = 95% H^+, 5% He^{++} with equivalent electrons;
Density = 1-10 particles/cm^3;
Velocity 450 km/s;
Energy (ions) 10 eV;
Energy (e^-) 50 eV;
Risk = Low surface charging potential[Jackson 1997].

Although, this plasma may be relatively benign compared to those at Low and Geosynchronous orbits it is still an applicable environmental mechanism at L2 and orbits around it.

Meteoroids & Orbital Debris:

In space environments meteoroids, small bits of cometary ice or rock, and orbital debris, man-made space litter, travel at 20-70 km/s and 10 km/s respectively causing yet another hazard, penetration/damage, for space operations and their vehicles. For this reason several models have been developed to characterize the quantity of meteoroid or debris objects in an operational area (i.e., orbit, trajectory, etc.).

The currently accepted model for debris predictions is the National Aeronautics and Space Administration (NASA) ORDEM96 model. This model utilizes debris size, space vehicle inclination, and altitude to predict debris flux (the amount of debris passing through a given area at a given time). This model has been correlated with measured flux data from LDEF and indicates that debris is concentrated in low Earth orbit ($\leq$ 2000 km) as would be expected based on debris generation rates and degradation trends. Therefore at the L2 point (1.5 million km from the center of the Earth) and the orbits around that point the debris threat can be considered negligible if in existence at all. However, with any mission to L2 or in orbit around that point debris conditions could change depending on the man-made activity's prudence with regard to debris generation.

The currently accepted model for meteoroid predictions is the NASA Technical Memorandum - 4527 model[Anderson 1994]. This model utilizes spacecraft altitude, diameter of the meteoroid, and particle density/mass to predict fluence. Utilizing this model meteoroid fluence at the L2 point (1.5 million km from the center of the Earth) and the orbits around the L2 point ranges from 162.355 meteoroid impacts/m^2/yr for meteoroids of 1×10^{-4} cm in diameter to 2.404×10^{-19} meteoroid impacts/m^2/yr for meteoroids of 700 cm in diameter, as shown in the Figures 2 and 3. Therefore meteoroids are an applicable environmental mechanism at L2 and the orbits around it.

Solar:

In space the sun contributes to the operational environment via solar pressure, solar light/albedos, and radiation. The effects of the latter are covered in the ionizing radiation section of this document.

Solar pressure is generated from the in coming solar light energy. At L2 the solar energy ranges from 1291 W/m^2 to 1421 W/m^2[NGST 1998], as referenced in the Thermal Section. This range includes the Earth's eccentricity and solar flares effects. However, solar flare and Earth eccentricity effects are negligible with regard to solar pressure. Therefore the nominal value of solar energy that imparts solar pressure at L2, negating the above referenced negligible effects, is 1360 W/m^2. Therefore using the speed of light (3×10^8 m/s) this energy can be converted into the effective solar pressure, 4.533×10^{-6} N/m^2, at L2 and the orbits around that point.

Figure 2: Meteoroid Predictions Graph

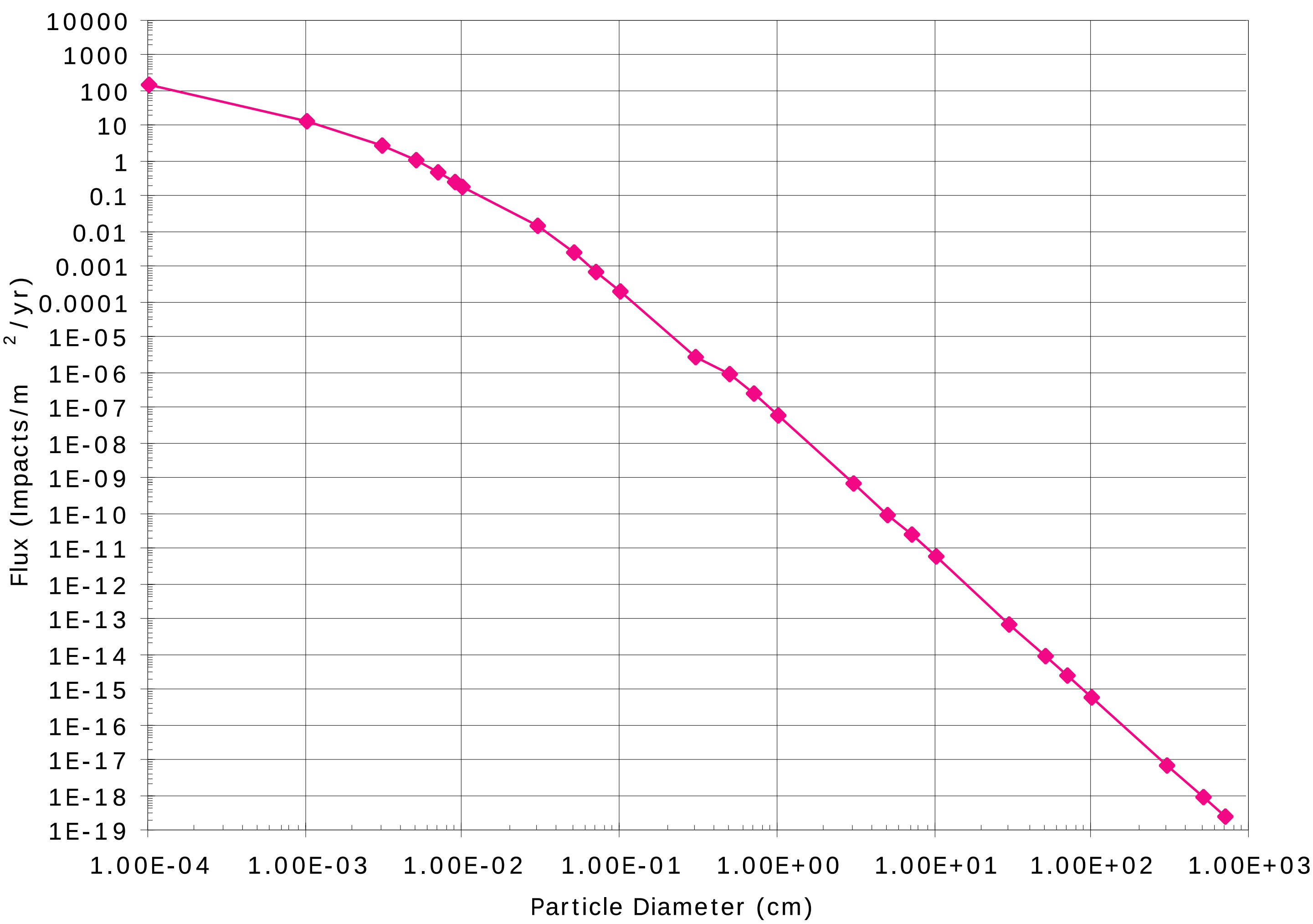


Figure 3: Meteoroid Predictions Table

Diameter (cm)	Intermediate Calculations of Mass @ All Rhos: Rho (g/cm^3) = 2	Rho (g/cm^3) = 1	Rho (g/cm^3) = 0.5	True Mass @ Diameter Using Rho Rules* (g)	$F^{ip}_r(m)$ =	Flux of Meteoroids (Impacts/m^2/yr)
1.00E-04	1.0467E-12	5.2333E-13	2.618E-13	1.04667E-12	1070.45491	1.62355E+02
1.00E-03	1.0467E-09	5.2333E-10	2.618E-10	1.04667E-09	93.6045785	1.41969E+01
3.00E-03	2.826E-08	1.413E-08	7.065E-09	2.826E-08	21.3617883	3.23992E+00
5.00E-03	1.3083E-07	6.5417E-08	3.2708E-08	1.30833E-07	7.88800246	1.19637E+00
7.00E-03	3.5901E-07	1.795E-07	8.9752E-08	3.59007E-07	3.62093594	5.49184E-01
9.00E-03	7.6302E-07	3.8151E-07	1.9076E-07	7.6302E-07	1.89958278	2.88108E-01
1.00E-02	1.0467E-06	5.2333E-07	2.6167E-07	1.04667E-06	1.42716563	2.16457E-01
3.00E-02	2.826E-05	1.413E-05	7.065E-06	1.413E-05	0.10014866	1.51895E-02
5.00E-02	1.308E-04	6.542E-05	3.271E-05	6.542E-05	0.01718496	2.60643E-03
7.00E-02	3.590E-04	1.795E-04	8.975E-05	1.795E-04	0.00508883	7.71818E-04
1.00E-01	1.047E-03	5.233E-04	2.617E-04	5.233E-04	0.00135087	2.04886E-04
3.00E-01	2.826E-02	1.413E-02	7.065E-03	1.413E-02	1.9569E-05	2.96804E-06
5.00E-01	1.308E-01	6.542E-02	3.271E-02	3.271E-02	6.5101E-06	9.87387E-07
7.00E-01	3.590E-01	1.795E-01	8.975E-02	8.975E-02	1.7206E-06	2.60960E-07
1.00E+00	1.047E+00	5.233E-01	2.617E-01	2.617E-01	4.1717E-07	6.32720E-08
3.00E+00	2.826E+01	1.413E+01	7.065E+00	7.065E+00	5.1785E-09	7.85411E-10
5.00E+00	1.308E+02	6.542E+01	3.271E+01	3.271E+01	6.6809E-10	1.01329E-10
7.00E+00	3.590E+02	1.795E+02	8.975E+01	8.975E+01	1.7316E-10	2.62637E-11
1.00E+01	1.047E+03	5.233E+02	2.617E+02	2.617E+02	4.1356E-11	6.27235E-12
3.00E+01	2.826E+04	1.413E+04	7.065E+03	7.065E+03	5.0072E-13	7.59439E-14
5.00E+01	1.308E+05	6.542E+04	3.271E+04	3.271E+04	6.4254E-14	9.74528E-15
7.00E+01	3.590E+05	1.795E+05	8.975E+04	8.975E+04	1.6614E-14	2.51987E-15
1.00E+02	1.047E+06	5.233E+05	2.617E+05	2.617E+05	3.9605E-15	6.00691E-16
3.00E+02	2.826E+07	1.413E+07	7.065E+06	7.065E+06	4.7808E-17	7.25104E-18
5.00E+02	1.308E+08	6.542E+07	3.271E+07	3.271E+07	6.1309E-18	9.29864E-19
7.00E+02	3.590E+08	1.795E+08	8.975E+07	8.975E+07	1.5848E-18	2.40369E-19

Note: $F(d) = s_f * G_E * F^{ip}_r(m)$ where G_E = 1+(Radius of the Earth/Altitude),
$F^{ip}_r(m) = c_0[(c_1 * m^{.306}+c_2)^{-4.38}+c_3(m+c_4m^2+c_5m^4)^{-.36}+c_6(m+c_7m^2)^{-.085}]$
s_f = (1+Cos(ASIN(RE/RE+H)))/2 where RE = 6478km, H= Alt -100km
Rho Rules*: 2 g/cm^3 for $m < 1E^{-6}$ g,
1 g/cm^3 for $1E^{-6} \le m \le 0.01$g,
0.5 g/cm^3 for $m > 0.01$g

Direct solar light and solar light reflected from the Earth and Moon can be harmful and or disruptive to sensitive science and or spacecraft instrumentation therefore solar light characteristics are part of the solar environmental mechanism. At L2 and the orbits around it, the solar constant is 1291-1421W/m^2 [NGST 1998] as mentioned earlier in the Thermal Section. However, at L2 and the orbits around it the spectrum of direct sunlight can be modeled as the blackbody spectrum (Range: 8.25x10^8 W/m^3 at 3x$10^{-7}\lambda$ to 7.25x10^8 W/m^3 at 1x$10^{-6}\lambda$ with a peak of 1.78x10^9 W/m^3 at 5x$10^{-7}\lambda$) shown in Figure 4 [Menzel 1998]. In addition to this direct solar light, sunlight reflected from the Earth and Moon is also present. This reflected light can be quantified by focusing on the blackbody spectrum (Figure 4) of the light being reflected and applying the maximum reflective area of the Earth/Moon that can be seen from L2 looking directly at that area, slant range to the Earth/Moon, and the reflectivity of the Earth (.33) or Moon (.12). The results of this quantification are that the reflected light from the Earth at L2 ranges from 65.6 W/m^3 at 3x$10^{-7}\lambda$ to 56.8 W/m^3 at 1x$10^{-6}\lambda$ with a peak of 136.8 W/m^3 at 5x$10^{-7}\lambda$ (See Figure 5) and the reflected light from the Moon at L2 ranges from 2.49 W/m^3 at 3x$10^{-7}\lambda$ to 2.20 W/m^3 at 1x$10^{-6}\lambda$ with a peak of 5.20 W/m^3 at 5x$10^{-7}\lambda$ (See Figure 6)[Menzel 1998].

Figure 4: Direct Solar Light Flux at L2

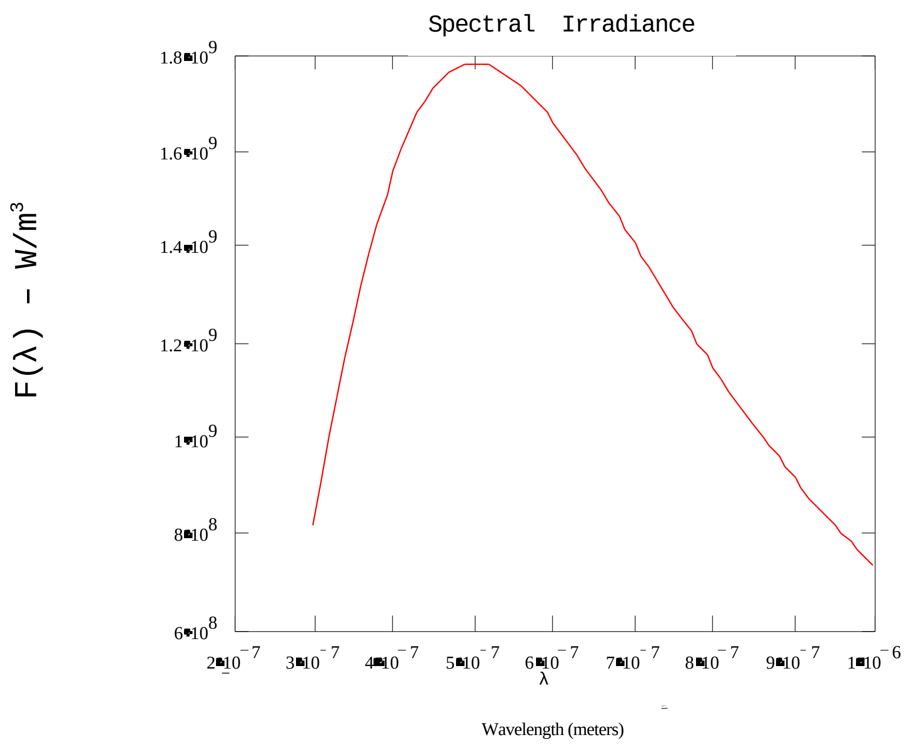


Figure 5: Earth Reflected Solar Light Flux at L2

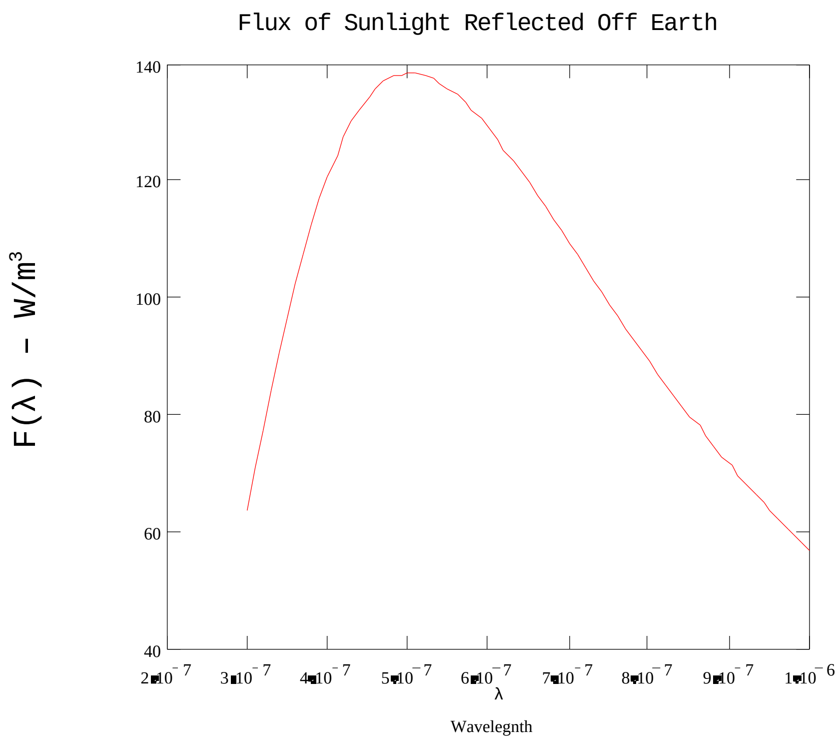
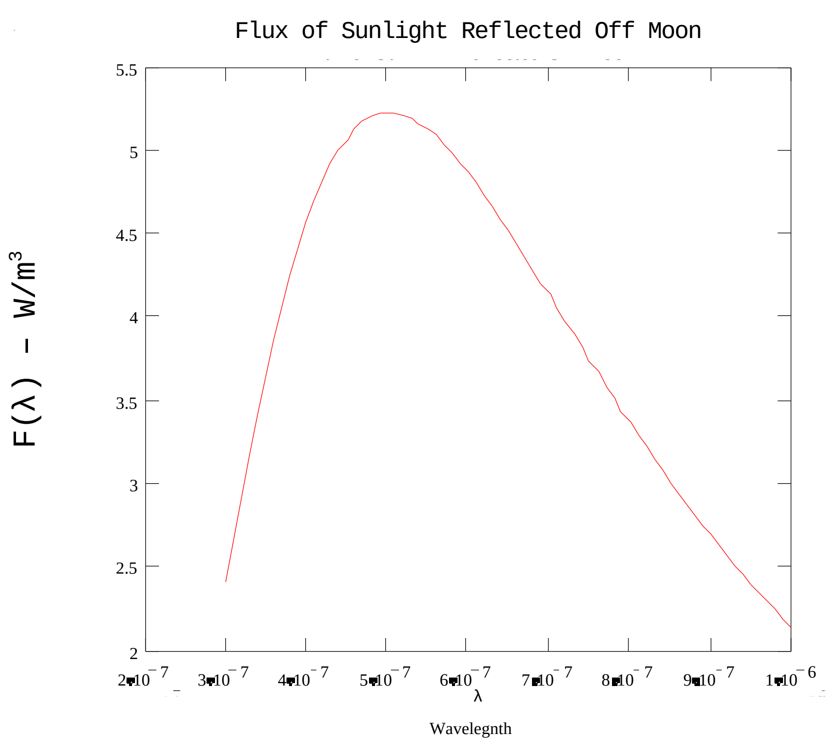


Figure 6: Moon Reflected Solar Light Flux at L2



Ionizing Radiation:

In space, radiation energy comes from three major sources geomagnetically trapped particles, solar flares, and galactic cosmic rays. The L2 point is at such a distance (1.5 X10^6km from the COE) from the Earth that the radiation effect of geomagnetically trapped particles can be considered negligible. The radiation effect of solar flares is produced by the high concentrations of energetic electrons in the flares and is in existence throughout the solar system and therefore is also at the L2 point and orbits around it. In addition, cosmic rays which originate outside the solar system and include heavy, unenergetic ions of elements such as iron contribute to ionizing radiation throughout the solar system and therefore also at the L2 point and the orbits around it.

The effects of these sources of radiation varies depending on altitude and solar cycle therefore models have been developed to quantify the total integral cosmic flux at a particular altitude and solar conditions. Currently these models are structured to support the Low-Earth (LEO) and Geosynchronous (GEO) orbits directly but they can also be run with particular variables eliminated to assess locations beyond Earthly orbits. Specifically, the accepted program "Space Radiation (Ver 2.5)" was executed at an altitude of 35,800km (GEO) with the geomagnetic shielding effect of the Earth eliminated which limits the radiation considered by the model to that of solar flares and cosmic rays. Since these are the only radiation sources that effect L2 and the orbits around that point a valid estimate of the total integral cosmic flux was attained and is shown in Figures 7 and 8[Lum 1998]. Therefore ionizing radiation is an applicable environmental mechanism at L2 and the orbits around it.

Figure 7: Integral Cosmic Flux Prediction Graph

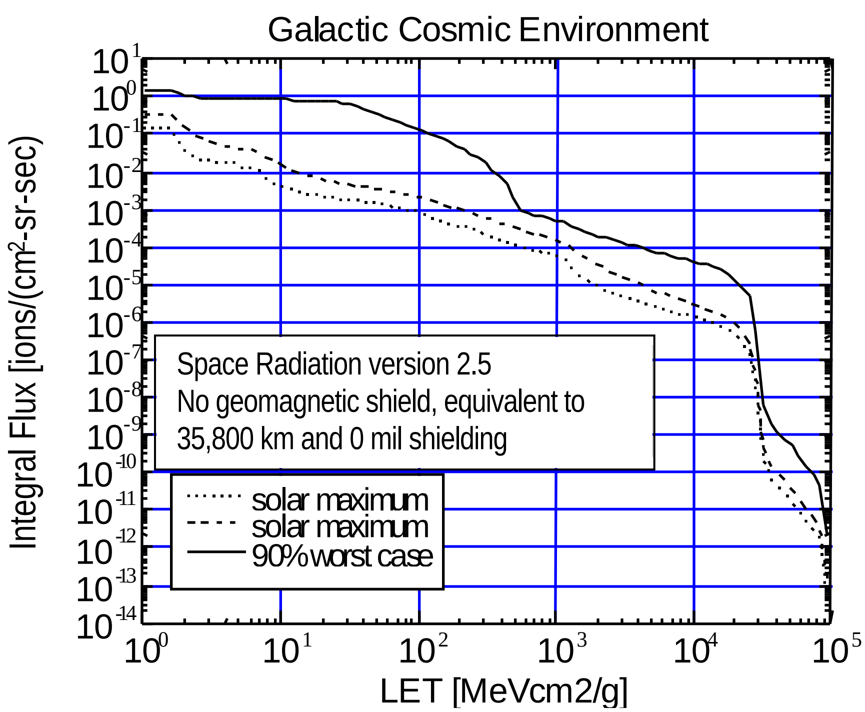


Figure 8: Integral Cosmic Flux Prediction Table

LET [MeVcm2/g]	Integral Flux [ions/(cm^2-sr-sec)] Solar Max.	Solar Min.	90% worst case
1.00E+00	1.42E-01	3.60E-01	1.40E+00
1.13E+00	1.42E-01	3.60E-01	1.40E+00
1.27E+00	1.42E-01	3.60E-01	1.40E+00
1.43E+00	1.42E-01	3.60E-01	1.40E+00
1.61E+00	1.42E-01	3.60E-01	1.40E+00
1.81E+00	6.13E-02	2.00E-01	1.14E+00
2.04E+00	3.13E-02	1.30E-01	1.03E+00
2.30E+00	2.48E-02	9.91E-02	9.77E-01
2.59E+00	2.13E-02	7.95E-02	9.44E-01
2.92E+00	1.91E-02	6.55E-02	9.22E-01
3.29E+00	1.77E-02	5.60E-02	9.06E-01
3.71E+00	1.68E-02	4.96E-02	8.95E-01
4.18E+00	1.63E-02	4.55E-02	8.89E-01
4.71E+00	1.59E-02	4.26E-02	8.84E-01
5.30E+00	1.56E-02	4.06E-02	8.81E-01
5.98E+00	1.55E-02	3.93E-02	8.79E-01
6.73E+00	1.34E-02	3.53E-02	8.72E-01
7.58E+00	8.00E-03	2.54E-02	8.55E-01
8.54E+00	5.98E-03	2.05E-02	8.46E-01
9.63E+00	4.96E-03	1.71E-02	8.39E-01
1.08E+01	4.22E-03	1.45E-02	8.31E-01
1.22E+01	3.65E-03	1.23E-02	8.23E-01
1.38E+01	3.23E-03	1.06E-02	8.14E-01
1.55E+01	2.91E-03	9.19E-03	8.03E-01
1.75E+01	2.65E-03	8.05E-03	7.88E-01
1.97E+01	2.46E-03	7.18E-03	7.70E-01
2.22E+01	2.31E-03	6.48E-03	7.47E-01
2.50E+01	2.19E-03	5.92E-03	7.16E-01
2.81E+01	2.08E-03	5.46E-03	6.75E-01
3.17E+01	1.97E-03	5.06E-03	6.18E-01
3.57E+01	1.87E-03	4.73E-03	5.43E-01
4.02E+01	1.79E-03	4.46E-03	4.66E-01
4.53E+01	1.66E-03	4.15E-03	4.00E-01
5.11E+01	1.58E-03	3.93E-03	3.43E-01

5.75E+01	1.52E-03	3.75E-03	2.93E-01
6.48E+01	1.29E-03	3.31E-03	2.49E-01
7.30E+01	1.16E-03	3.02E-03	2.12E-01
8.23E+01	1.09E-03	2.80E-03	1.80E-01
9.27E+01	9.77E-04	2.55E-03	1.52E-01
1.04E+02	9.17E-04	2.37E-03	1.28E-01
1.18E+02	6.93E-04	1.93E-03	1.06E-01
1.32E+02	5.88E-04	1.67E-03	8.73E-02
1.49E+02	5.23E-04	1.48E-03	7.15E-02
1.68E+02	4.73E-04	1.33E-03	5.84E-02
1.89E+02	4.09E-04	1.16E-03	4.68E-02
2.13E+02	3.68E-04	1.03E-03	3.70E-02
2.40E+02	3.39E-04	9.30E-04	2.91E-02
2.71E+02	2.75E-04	7.83E-04	2.24E-02
3.05E+02	2.39E-04	6.82E-04	1.69E-02
3.44E+02	1.98E-04	5.78E-04	1.23E-02
3.87E+02	1.63E-04	4.86E-04	8.58E-03
4.36E+02	1.42E-04	4.19E-04	5.43E-03
4.92E+02	1.23E-04	3.59E-04	2.42E-03
5.54E+02	1.09E-04	3.13E-04	9.96E-04
6.24E+02	9.77E-05	2.76E-04	8.92E-04
7.03E+02	8.70E-05	2.42E-04	7.98E-04
7.92E+02	7.84E-05	2.15E-04	7.16E-04
8.92E+02	7.05E-05	1.90E-04	6.41E-04
1.00E+03	6.27E-05	1.67E-04	5.72E-04
1.13E+03	5.55E-05	1.47E-04	5.09E-04
1.28E+03	2.97E-05	9.88E-05	4.01E-04
1.44E+03	1.91E-05	7.25E-05	3.31E-04
1.62E+03	1.41E-05	5.54E-05	2.76E-04
1.82E+03	1.11E-05	4.35E-05	2.42E-04
2.05E+03	8.86E-06	3.41E-05	2.12E-04
2.31E+03	7.24E-06	2.71E-05	1.87E-04
2.61E+03	6.03E-06	2.17E-05	1.65E-04
2.94E+03	5.10E-06	1.75E-05	1.46E-04
3.31E+03	4.38E-06	1.43E-05	1.30E-04
3.73E+03	3.79E-06	1.18E-05	1.15E-04
4.20E+03	3.31E-06	9.80E-06	1.02E-04
4.73E+03	2.91E-06	8.23E-06	9.10E-05
5.33E+03	2.55E-06	6.88E-06	7.98E-05

6.01E+03	2.28E-06	5.89E-06	7.16E-05
6.77E+03	2.04E-06	5.04E-06	6.37E-05
7.62E+03	1.80E-06	4.26E-06	5.57E-05
8.59E+03	1.64E-06	3.76E-06	5.09E-05
9.67E+03	1.48E-06	3.26E-06	4.57E-05
1.09E+04	1.32E-06	2.83E-06	4.08E-05
1.23E+04	1.16E-06	2.40E-06	3.54E-05
1.38E+04	9.96E-07	2.01E-06	3.03E-05
1.56E+04	8.33E-07	1.65E-06	2.53E-05
1.76E+04	6.53E-07	1.28E-06	1.98E-05
1.98E+04	4.68E-07	9.21E-07	1.42E-05
2.23E+04	3.06E-07	6.00E-07	9.26E-06
2.51E+04	1.67E-07	3.29E-07	5.07E-06
2.83E+04	2.01E-08	3.96E-08	6.10E-07
3.19E+04	2.15E-10	4.37E-10	6.45E-09
3.59E+04	6.77E-11	1.42E-10	2.01E-09
4.04E+04	4.17E-11	8.72E-11	1.24E-09
4.55E+04	2.54E-11	5.30E-11	7.55E-10
5.13E+04	1.63E-11	3.37E-11	4.85E-10
5.78E+04	9.11E-12	1.89E-11	2.72E-10
6.51E+04	4.68E-12	9.70E-12	1.40E-10
7.34E+04	2.87E-12	5.81E-12	8.64E-11
8.27E+04	1.36E-12	2.70E-12	4.13E-11
9.31E+04	6.18E-14	1.23E-13	1.87E-12

Magnetic & Gravitational Fields:

Gravitational and magnetic fields exist throughout space and can be disruptive to orbits and may cause ESD. Therefore these fields are considered applicable environmental mechanisms at L2 and the orbits around it as quantified below.

Interplanetary magnetic fields exist throughout the solar system and therefore at L2 and the orbits around that point. The Earth's magnetosphere reaches out to 6 -10 Earth radii on the sunward side of the Earth and forms a magnetotail that extends to 1000 Earth radii, on the farside of the Earth. The L2 point is at 236 Earth radii. Therefore L2 and the orbits around that point are effected by the magnetotail and interplanetary magnetism not the magnetosphere of the Earth. Measurements of the magnetic field of the magnetotail range from 2 – 10nT and the interplanetary field is approximately 5nT[Barth 1997].

The gravitational forces at L2 are generated by the bodies (Earth, Sun, and Moon) that give this point its known gravitational equilibrium. However, the L2 point's gravitational equilibrium does not extend to points even slightly off of L2 or to the orbits around it. Therefore the effects of the gravitational fields of the Earth, Sun, Moon can be quantified including the effects of the Earth's elliptical orbit as shown in Figure 9A & B [Cassell 1998].

Figure 9A: Gravitational Force Predictions for the L2 Point

Effecting Body	Distance to L2 Earth Max Dist.	Distance to L2 Earth Min Dist.	Gravitational Force [N/kg$_{s/c}$] Earth Max Dist.	Gravitational Force [N/kg$_{s/c}$] Earth Min Dist.
Sun	1.537E08 km	1.486E08 km	5.620E-3 N/kg	6.008E-3 N/kg
Earth	1.538E06 km	1.478E06 km	1.685E-4 N/kg	1.824E-4 N/kg
Moon	1.150E06 km	1.872E06 km	3.709E-6 N/kg	1.399E-6 N/kg

Figure 9B: Gravitational Force Predictions for an NGST-type Halo Orbit Around L2

Effecting Body	Dist. to Closest* Orbital Point	Dist. to Farthest* Orbital Point	Gravitational Force [N/ kg$_{s/c}$] Orbital Closest Pt.	Gravitational Force [N/ kg$_{s/c}$] Orbital Farthest Pt.
Sun	1.502E8 km	1.489E8 km	5.879E-3 N/kg	5.990E-3 N/kg
Earth	1.213E6 km	1.674E6 km	2.706E-4 N/kg	1.423E-4 N/kg
Moon	1.361E6 km	1.810E6 km	2.645E-6 N/kg	1.497E-6 N/kg

*Note: Closest Orbital point occurs at the orbital point closest to the Earth on the Earth –Sun line at its worst case gravity effect which occurs at insertion.
Farthest Orbital Point is the orbital point farthest away from the Earth on the Earth-Sun line at its worst case gravity effect which occurs when due to the Earth's elliptical orbit it is closer to the Sun.

Conclusion:

The L2 natural environment and the environment of the orbits around that point as referenced above are relatively benign compared to those of Geosynchronous and Low-Earth orbits. The effects of the effective environmental mechanisms will still need to be factored in to the design of spacecraft intended to operate at these locations. Specifically, the following design considerations and trades will have to be analyzed based on spacecraft performance requirements:

- Thermal Protection and Control
- Charge Build-up Potential
- Material and Surface Penetration Potential

- Orbital and Attitude Disturbance and Control
- Noise Source Mitigation
- Radiation Shielding
- Launch/Trajectory Planning.

In addition to considering the L2 natural environmental impacts to a design, the impact of the environments encountered in the candidate trajectories to L2 and the orbits around it must also be quantified and factored into spacecraft/observatory design decisions. However, trajectory environments vary with respect to the trajectory planned and are therefore a programmatic variable. Therefore further analyses must be done on a program-by-program basis for those programs (i.e., MAP, NGST) that will go to the L2 point or orbit it to assess the full (operational and trajectory) environmental impact on their preliminary design to arrive at a final design that will achieve a safe and successful mission.

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