# Solar Electron Flux[1]

## *Dark Electrons Found by NASA*

**(Latest Update June 2013)**

In the late 1970's Ralph Juergens investigated[2] how (or whether) the Sun could be obtaining its energy via an externally supplied flow of electrical power. He attempted to estimate the number of available incoming electrons which, coupled with an estimated voltage of the Sun, would be sufficient to supply the power we know the Sun is emitting. In late 2011 and early 2012-2013, we found that, because of data recently recovered by the Voyager I space probe, Juergens' estimate of the number of available incoming electrons was far too conservative (too low). Also the radius of the heliosphere is over three times what he thought it might be. As a result of this new data, Juergens' initial estimate of the Sun's required cathode drop (voltage) was far too high.

The NASA release entitled *NASA's Voyager Hits New Region at Solar System Edge*[3] provides the following important updates to the information Juergens used in making his estimate:

- Voyager I is (as of 9/9/2012) approaching the heliopause (the outer surface of the Sun's plasmasphere). It is approximately $1.82264 \times 10^{10}$ km (18 billion kilometers or ~122 AU) from the Sun. The probe reportedly has not yet crossed the boundary into interstellar space, so this is a minimum official estimate of the radius of the heliosphere.
- Voyager has detected a 100-fold increase in the intensity of high-energy electrons entering our solar system from elsewhere in the galaxy. The original estimate was 100,000 free electrons per cubic m. Thus the updated figure is $\sim 10^7$ /m$^3$.
- The probe has been measuring the speed of the solar wind and for the first time in its journey, the wind now "blows back at us."

Using this new data we can recalculate Juergens' estimate of how many incoming electrons are available to the Electric Sun model. The 'solar constant', defined as the total radiant energy at all wavelengths reaching an area of one square centimeter at the Earth's distance from the Sun, is about 0.137 watts per square centimeter[4]. It works out, then, that the Sun must be emitting about $6.5 \times 10^7$ watts per square meter of solar (photospheric) surface, and therefore the total power output of the Sun is approximately $4 \times 10^{26}$ watts. Incidentally we observe that $6.5 \times 10^7$ watts per square meter of photospheric surface is equivalent to ~42,000 watts/inch$^2$.

Any hypothetical electric input must then provide a power of $4 \times 10^{26}$ watts. Juergens posited that the Sun's cathode drop is of the order of $10^{10}$ volts. In that event, the total power input divided by that voltage is $\mathbf{4 \times 10^{16}}$ amperes. The velocity of the interstellar winds is estimated[5] at 200 – 1000 km/s. This is in the range $2 \times 10^5$ and $10^6$ m/s. So let us suppose that the effective velocity of a typical interstellar electron is at least $10^5$ m/s.

At the time Juergens made his calculation (1979), current estimates of the state of ionization of the interstellar gas were that there should be at least 100,000 free electrons per cubic m. But in light of the new update (see #2 above), this is now increased 100 fold to $10^7$/m$^3$. The random electric current of these electrons would be $I_r = Nev$ where $N$ is the electron density per cubic meter, $e$ is the electron charge in coulombs, and $v$ is the average velocity of the electrons (in m/s). Using these values, we find that

$$I_r = Nev$$
$$= 10^7 \text{ electrons x } 1.6\text{x}10^{-19} \text{ Coulombs/electron x } 10^5 \text{ m/s}$$

so the random electric current density is about $1.6\text{x}10^{-7}$ Amp per square meter through a surface oriented at any angle.

The total electron current that can be drawn by the solar discharge is the product of this random current density and the surface area of the sphere occupied by the cathode drop. We now (see update #1 above) have a better measurement of how large this sphere is. Its radius is approximately $2\text{x}10^{13}$ m, so its spherical boundary must have a collecting surface area of something greater than $5\text{x}10^{27}$ square meters.

Such a surface would then collect a current of interstellar electrons amounting to approximately $1.6\text{x}10^{-7}$ Amp per square meter x $5\text{x}10^{27}$ square meters = **$8\text{x}10^{20}$ A**. (Some **20,000** times the number needed!). Of course this calculation involves many estimated quantities, but they are the best estimates available to science today (Fall 2012).

This calculation makes it clear that it is ***not*** reasonable to conclude that there are not enough electrons entering the Sun's environment to power it. In fact, in light of the new NASA data, it is now possible to reduce our estimate of the Sun's voltage to ~ $10^{10}$/16,000 = 0.5 million volts = 500 kV which, relatively speaking, is not extremely large. There are commercial transmission lines here on Earth using higher voltages[6].

NASA's observation (#3 above) that the direction of the solar wind actually reverses (begins to flow sunward) out near the heliopause is further confirmation that the analogy between the behavior of the Sun's surrounding plasma and what is observed in laboratory "gas" (plasma) discharge tubes is a valid one. Near the cathode of such a tube, a layer of electrons is often observed. Such a layer creates a negative electric field (force per unit charge) applied to positive charge carriers (+ions in the solar wind). The heliopause is a virtual cathode for the Sun's plasma discharge.

A standard criticism from skeptics of Juergens' Electric Star hypothesis has always been, "where are all the necessary incoming relativistic electrons?" First of all, the incoming electrons do not have to be (will not be) relativistic. Secondly, it appears NASA is in the process of finding them. Perhaps Electrical Universe theoreticians should issue a press release entitled "Dark Electrons Found by NASA." For this reason this short paper carries that sub-title.

## *First Addendum (2013)*

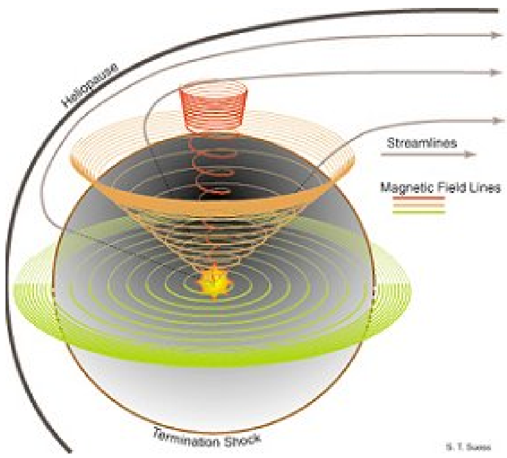


**Figure 1. Magnetic spirals (currents) discovered by Space probe Ulysses.**

1. In the calculation described above there is an assumption that the heliopause collects electrons isotropically from its surrounding interstellar plasma. In light of data received from the Ulysses probe (1990-2008) it is now known that there are strong magnetic fields above the Sun's poles. Such spiral fields cannot exist in the absence of strong spiral electric currents. The spirals apparently get tighter (narrower, more dense) as they near the solar surface. Thus we conclude that the solar polar regions may experience vastly stronger current densities than lower latitude regions. So, not only are the charge carriers amply available to power the Sun, we are beginning to have an idea of where and how they enter the Sun.

2. The calculation presented in the first part of this report concludes that as many as 20,000 times the required number of electrons may be collected from outside the heliopause as are needed to power the Sun electrically. A logical conclusion from this is that only 1/20,000th of the total population of electrons in the Sun's vicinity need to drift toward the Sun.

3. Plasmas have what is called the "*plasma frequency*". Even after an electron is freed from an atom (producing an ionized ion/electron pair) that electron tends to oscillate around the +ion at a certain frequency. The electron is free to drift away from the ionic center, but often continues to dance around it until it jumps over to the vicinity of another ion. Visualize a set of 20,000 (ionized) ion/electron pairs in a plasma where only one of them at a time jumps (drifts) to a neighboring ion. The vast sea of dancing (in Brownian motion) electrons easily camouflages the drift motion of one out of 20,000 electrons. That is why the criticism of the Juergens ES model that says, "We only see equal numbers of ions and electrons moving in the solar wind." Is not a valid one.

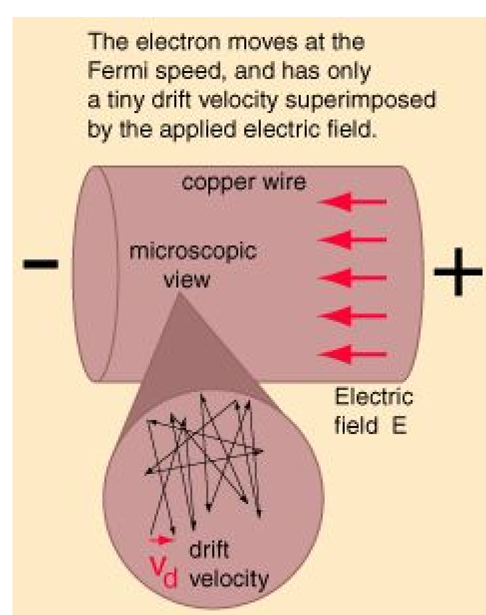


**Figure 2 Drift electrons are difficult to see.**

One critic of the Juergens electric Sun model has said, “The appearance of the photosphere at the poles of the Sun seems to be the same as it is at lower solar latitudes. Doesn’t that disprove the idea that a concentrated polar flow of charge is located in the polar regions?”

No, it does not, because the powering flow of charge is only a tiny fraction of the ambient ion/electron population. That is not enough to change the character of the photospheric plasma.

## *Second Addendum (June 2013)*

Juergens’ analysis presented above considers the Sun to be analogous to a resistor in an electric circuit. This simple model concentrates solely on electron flow. It omits the fact that positively charged ions also play a part in the effective current that passes through the Sun. In common electric circuits (in metal wire conductors) the only charge carriers are electrons. No positive charges such as +ions are able to move. They are locked in place in the crystals that make up the solid-state metal conductors. But in plasma both electrons and +ions are present to carry charge and move around.

Electric charge is measured in coulombs, (C). The rate at which positive electric charge moves past an observation point is called an ***electric current***. The direction of motion of those ***positive*** charges is called (by definition) the direction of the current. Current is measured in amperes (A) and is usually given the symbol, *i*, where

$$i = \frac{dq}{dt} \qquad (1)$$

It is the net flow of charge that is important. Negative charge flowing toward the left contributes positively to a net current, *i*, that moves toward the right. For example in figure 3, below, suppose a charge of 3 C of positive charge moves towrd the right every ½ second. Simultaneously a charge of -5 C moves toward the left every 1/3 second. The resulting current is calculated as being:

$$i = \frac{3}{1/2} - \frac{-5}{1/3} = 21\,A \qquad (2)$$

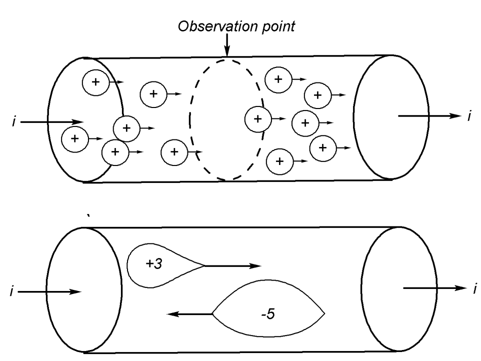


**Figure 3. (Top) Current is the rate at which positive charge moves past an observation point. (Bottom) A current made up of both kinds of charge.**

In expression 2, above, the first minus sign is due to the leftward (negative) direction of the second charge. The second minus sign is due to the negativity of the charge itself.

Within a laboratory plasma more electrons than +ions can (and often do) exist. This is because no +ions can flow in the external wires connected to the anode and cathode electrodes of the discharge. But within the plasma discharge itself, we must include the contributions of both types of charge carriers to the total current.

In a lab discharge electrons are given off by the cathode. They come into the discharge plasma (usually in pairs) from the wire connected to the cathode terminal. One of these electrons is accelerated off toward the anode and one recombines with an incoming +ion (thus creating a neutral atom and reducing the number of +ions in the plasma by one). The first electron speeds away toward the anode and may hit a neutral atom somewhere in the middle of the discharge. It survives, and the collision produces another electron (and a +ion which replaces the one just neutralized near the cathode). The two electrons impinge on the anode, are absorbed into it, and go off, down, inside the wire connected to the anode. The +ion is accelerated toward the cathode.

In the center of the plasma discharge described here, +ions are traveling from the anode toward the cathode. An equal number of electrons are traveling the other way. Each of these streams contribute equally (1/2 of the total) to the current that is measured externally by an ammeter in series with the discharge tube. But in space there are no wires or ammeters.

Therefore the question arises ***why did Juergens only consider electron flow when he calculated the constituents of the total current in the solar plasma?*** It seems he was fixated on the electric circuit analogy wherein only electron flow is important. In the cosmos, there are no prohibitions against long distance travel of +ions. There are no signs that say, "No ions allowed beyond this point" as there are (figuratively) placed in front of cathodes in every lab discharge.

Therefore, if we make the estimate that there are as many +ions moving near and through the Sun as there are electrons (the 'quasi-neutral' assumption), ***the requisite number of electrons can be cut in half.*** The required number of electrons to power the Sun electrically is thus ***one out of every 40,000*** that the Sun takes in from its environment near the heliopause.

Juergens' Electric Sun hypothesis seems to be increasingly supported by every new bit of data NASA releases.

D.E. Scott (June 2013)

---

[1] From Appendix C of *The Electric Sky*, Scott, D.E., Mikamar 2006.

[2] Available: http://www.kronos-press.com/juergens/k0801-electric-i.htm
and http://www.kronos-press.com/juergens/k0802-electric-ii.htm
or http://www.kronos-press.com/juergens/1982-electric-solar-energy-juergens.pdf

[3] Available: http://www.jpl.nasa.gov/news/news.cfm?release=2011-372

[4] Wilson, R.C. , *Journal of Geophysical Research*, 83,4003-4007 1978.

[5] Peratt, A. *Physics of the Plasma Universe*, Springer-Verlag, 1992.

[6] Highest transmission voltage (AC): 1.15 MV on Powerline Ekibastuz-Kokshetau (Kazakhstan)
http://answers.yahoo.com/question/index?qid=20091022010949AAIY7dZ