The Electronic Sun

Summary Notes

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Part I.

Why the Lower Corona of the Sun Is Hotter Than the Photosphere

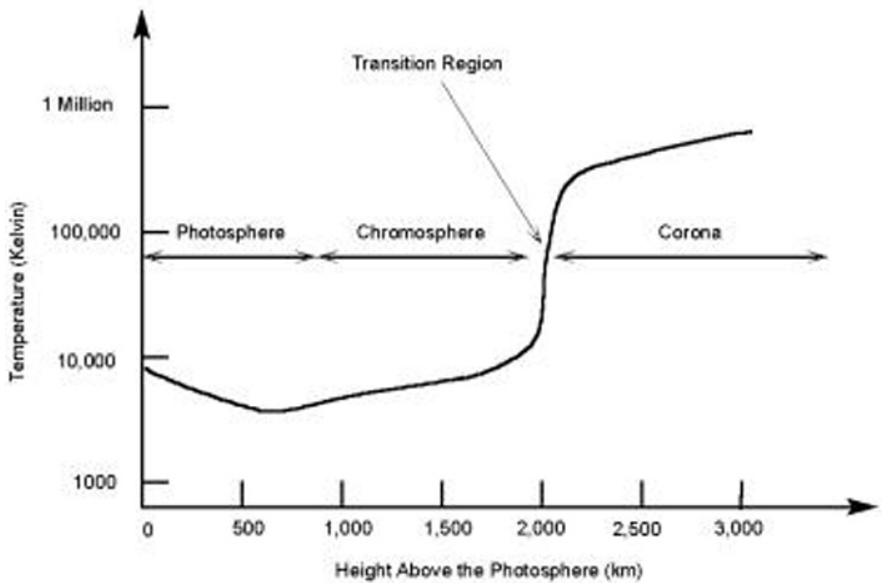

Figure 1 Temperature vs Altitude Above the Sun's Surface.

The temperature profile of the Sun shown in figure 1 resists simple explanation. Of all the ideas offered up as being a possible cause of the extreme temperature (more than 2 million Kelvin) measured in the lower corona of our Sun, the simplest is that electrically accelerated, high velocity, positive ions are colliding with relatively static ions and neutral atoms in that location. The resulting chaos of Brownian motion produces the high temperature that is measured at that level. See the right hand side of figure 1.

The electrical properties of the Photosphere / Chromosphere / Lower corona region of the Sun's visible boundary are described in Juergens Electric Sun model as being dominated by a double layer (DL) of electrical charge[i]. This double charge layer is shown in the middle plot in figure 2 (below). This DL is responsible for accelerating +ions outward, up from the Sun's surface. The basic mechanism is described as follows.

Positive ions in the photospheric plasma do not experience external electrostatic forces when they are within the photosphere (region *a* to *b* in figure 2). Only diffusion motion (response to a concentration gradient) and random thermal (Brownian) movement occurs there. Temperature is simply the measurement of the violence of those random movements. The photosphere is where the Sun's low ~5800 K surface temperature is measured. Figure 2 shows a cross-section through a photospheric granule (anode tuft).

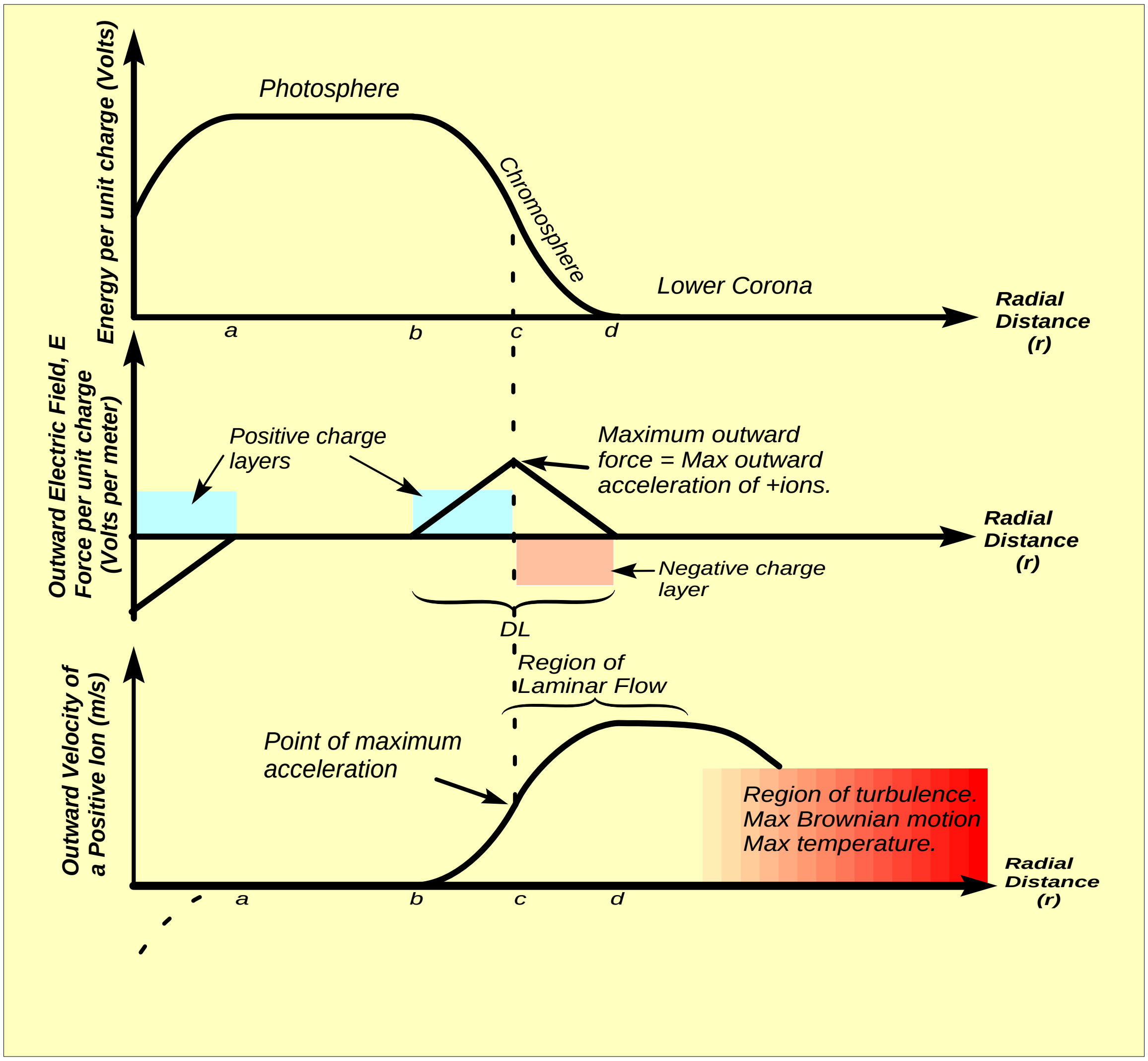

Figure 2. The double layer of electrical charge in the Electric Sun's chromosphere accelerates positive ions outward, away from the Sun.

Top: Electrical energy (voltage) of a positive ion as a function of its position.
Middle: Outward force on a positive ion as a function of its position.
Bottom: Outward velocity of a positive ion as a function of its position.

The top voltage plot in figure 2 shows that positive ions have their maximum ***electrical potential energy*** when they are in the photospheric plasma. But their ***mechanical (kinetic) energy*** (temperature) is relatively low. At a point just to the left of the right hand edge of the photospheric energy plateau (point *b*), any random movement toward the right (radially outward) that carries a +ion even slightly over the edge will result in its being swept away, down the energy hill, toward the right.

The middle plot in the figure above shows the strength of the ***E***-field (voltage gradient) consistent with this spatial voltage distribution. The charge density layers that produce this electric field are superimposed on this plot. The ***E***-field is the force per unit charge that will be applied to any +ions in this region. In region *b* to *d,* this force accelerates each such +ion in the outward direction. This acceleration reaches a maximum at point *c*, and the +ions' outward velocity reaches a maximum value near point *d*.

As these positive ions accelerate down the steep potential energy drop (*b* to *d*), they exchange the high (electrical) potential energy they had in the photosphere into kinetic energy – they gain extremely high outward radial velocity and lose side-to-side random motion. Thus they become 'de-thermalized.' This is because in this region of high radial acceleration, the movement of these ions becomes extremely organized (parallel). Their temperature, which is just a measure of their random motion, drops to a minimum.

When these rapidly traveling +ions pass beyond the reach of the intense outwardly directed ***E***-field force (at point *d*) that has been accelerating them, they have reached the bottom of the hill and are moving much faster than when they were at the top. Because of their high kinetic energy, any collisions they have at this point with other ions or neutral atoms are violent. This creates high-amplitude random motions, thereby 're-thermalizing' the ions and atoms in this region (shown in red in figure 2) to a much higher temperature. The sparkling x-ray emissions that have been observed here in the lower corona are undoubtedly due to these collisions.

Ions above (in the diagram, to the right of) point *d* are reported to be at temperatures of one to two million K. Nothing else but exactly this kind of result could be expected from the Electric Sun model. The ions proceed off to the right and become the major constituent of the solar wind.

The re-thermalization takes place in a region analogous to the turbulent white water that boils up at the bottom of a smooth laminar water slide. In the fusion model no such (water slide) phenomenon exists – and therefore neither does any simple explanation of the observed temperature discontinuity.

Notice that no mention has been made in this process of 'flux-tubes' or magnetic reconnection or, in fact, of *any* magnetic mechanism whatsoever. Strictly electrical forces that occur within the charge layers above the Sun's surface cause the observed temperature inversion phenomenon.

So, the *Electric* Sun model straightforwardly predicts and explains the existence of the observed temperature profile. In fact, if there were no temperature discontinuity, this would pose a problem for the Electric Sun hypothesis. However, until now, certain other observed characteristics of the Sun's atmosphere have eluded explanation.

One such problem in solar astronomy is: What mechanism can vary the strength of the solar wind (outward flow of +ions) and even shut it completely off for a period of two days as happened a few years ago?

Oftentimes in the history of science a seemingly intractable problem finds its resolution when someone recognizes that the solution to a different but analogous problem already has been discovered. As described in the following section, it appears that the charge layers in the Juergens Electric Sun model described above constitute a direct one-to-one analogy of a bipolar junction transistor mechanism that is fully capable of regulating, controlling, or varying the solar wind's volume and intensity.

Part II

Transistor Analog of the Sun's Surface

A bipolar junction transistor is a three terminal active device wherein a weakly varying voltage is able to control the amplitude of a large current. The following few paragraphs contain a basic description of how that occurs.

Inserting certain impurities into either a pure silicon or germanium crystal makes it n-type or p-type material. A bipolar transistor is a three-part sandwich: either pnp or npn.

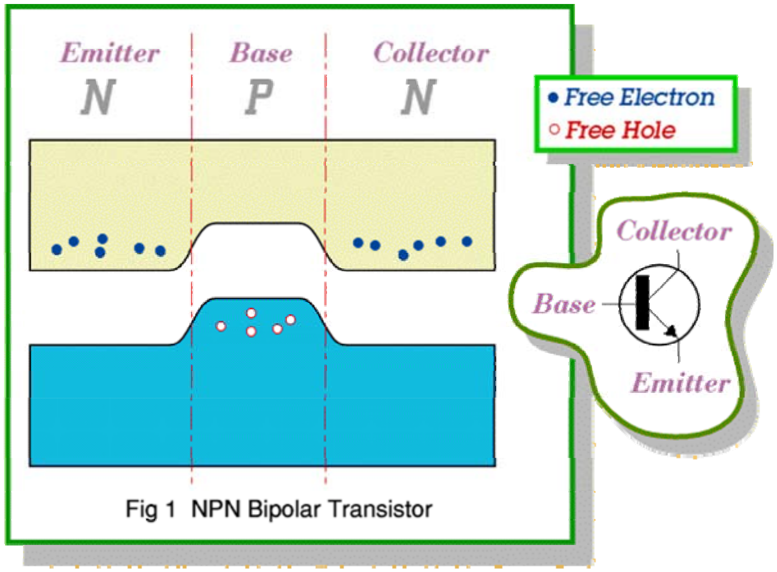

Figure 1. An unbiased npn transistor. The vertical axis is electric potential energy per unit charge (Volts).

(Credit: The Scots Guide to Electronics[ii])

In n-type material, electrons move freely within the conduction energy band (upper band in figure 1). In p-type material holes move in the valence energy band (lower band in figure 1). Where two such different materials join, a depletion zone (location shown by the two vertical red lines in figure 1) forms due to recombination. The lack of charge carriers in those zones is sufficient to prevent current (charge flow) crossing those two boundaries.

If an external voltage is applied (see figure 2) between the base and collector terminals, then the height of the base-to-collector voltage drop can be increased. In this case the positive terminal of a 10V battery is applied to the n-type collector and the negative side of the battery is applied to the p-type base. This is called "back biasing" the base-collector junction. In the collector, electrons are attracted toward the collector terminal and away from the base. In the base, holes are attracted away from the collector. Both these actions widen the b-c depletion zone and increase the height of the b-c voltage drop.

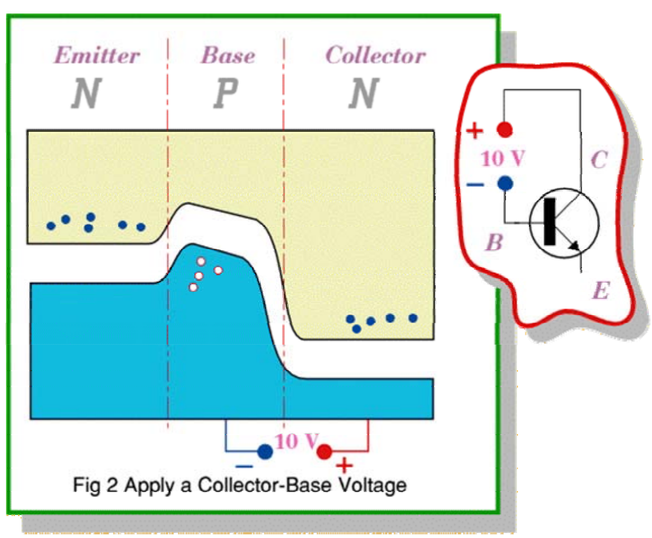

Figure 2 Back biasing the collector-base junction increases the height of the c-b barrier.
(Credit: The Scots Guide to Electronics[iii])

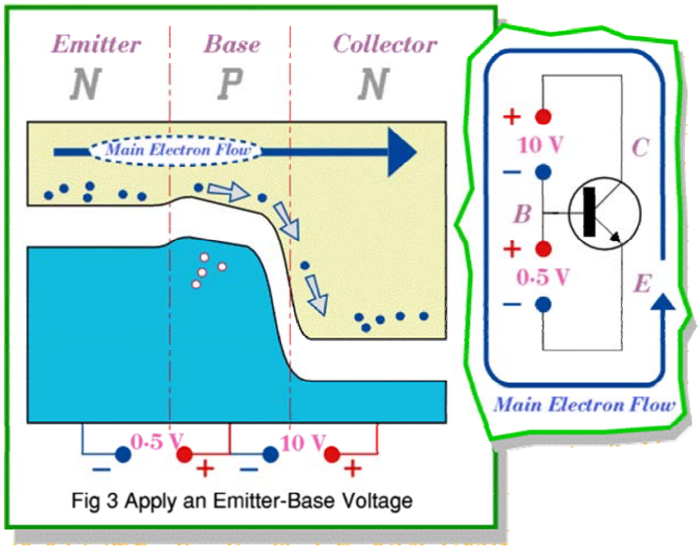

Figure 3 Forward biasing the emitter-base junction reduces the height of the e-b barrier.
(Credit: The Scots Guide to Electronics[iv])

Normal operation

Forward-biasing the e-b junction while maintaining the back bias voltage across the b-c junction provides the voltage profile shown in figure 3. This reduces the height of the e-b barrier and electrons flow from the emitter, diffuse across the base and fall into the collector. A slight change in the e-b voltage produces a large change in the amount of current reaching the collector. This is the normal operating mode of a bipolar transistor. It is important that we recognize the similarity between the shape of the voltage profile in this figure and the voltage profile in Part I's figure 2. The collector current is analogous to the outward drift of +ions in the solar wind.

A similar mechanism (varying the height of the voltage barrier between the anode-Sun and its photosphere) would be able to control the strength of the solar wind. If the Sun's voltage were to decrease slightly, say because of an excessive flow of outgoing +ions, the voltage rise (the energy barrier) from the origin up to point *a* in the energy diagram of figure 2 (Part I) would increase in height. This would reduce the number of ions able to escape from the Sun's interior into the photosphere (thus decreasing the solar wind flux). Such an effect provides a negative feedback effect (one that would tend to hold the solar wind constant).

The solar/transistor analogy lies in recognizing the fact that the body of the Sun serves as the emitter of a transistor-like structure. The photosphere serves as the base, and the lower corona serves as the collector. In the case of a transistor, the controlled flow is the collector current. In the Sun, the controlled flow is the stream of +ions that becomes the solar wind. Both these flows are controllable by relatively small variations in the height of voltage barriers. A diagram describing the analogy is given in figure 4, below.

As with any analogy, broad similarities are revealing. Exact correspondences are not necessary. The transistor/Sun analogy is clearly not one-to-one in every respect. But generally similar causes and effects in radically different applications do offer insights into conceptual similarities that are otherwise elusive. The ability of digital transistor circuits to "cut-off" collector currents and the ability of the layers of charge above the Sun's surface to cut off the solar wind is an example of such a similarity. The solar wind did indeed completely cut off for two days several years ago. When this occurred it came as a shock to solar astronomers. The standard solar model is incapable of explaining how or why this might have occurred. An unpredicted rise in the tufts' barrier voltage could have easily been the cause.

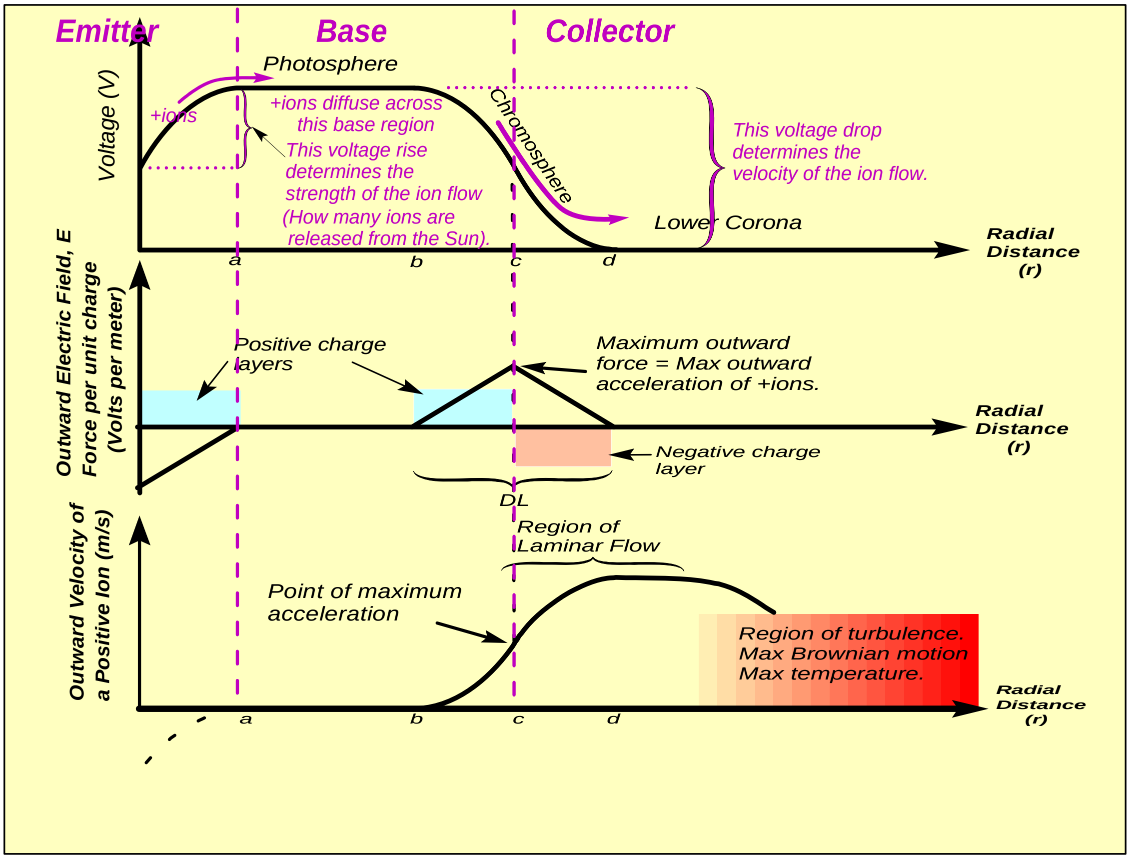

Figure 4 The transistor analog of the electrical mechanisms at work at the solar surface.

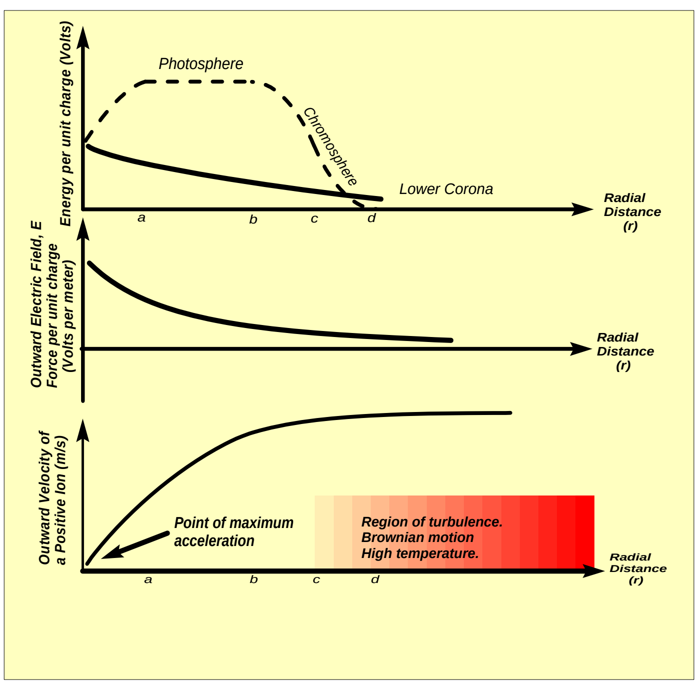

Figure 5 Punch-through effect of solar +ions flooding out from sunspots at which DLs are not present. (Credit: SOHO-MDI/EIT Consortiums, Yohkoh/SXT Project)

Punch-through and sunspots

In bipolar transistors a phenomenon called punch-through can be observed. If the collector-base junction is back-biased to an excessive degree, the c-b depletion zone will be made so wide that the base region may disappear altogether. In this event there will be no restraint to hold back emitter carriers from flooding directly across into the collector. There is no effective emitter-base barrier. An analogous phenomenon is observed above sunspots where there are no anode tufts. So, at those locations no transistor-like mechanism is there to provide effective control of outward flowing +ions. See figure 5 and figure 6.

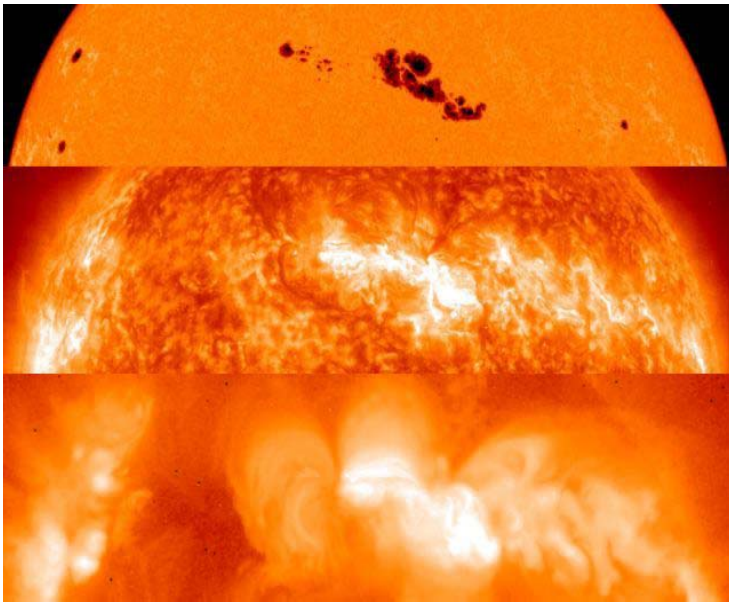

Figure 6. The solar equivalent of transistor punch-though where +ions flood outward unconstrained by the photospheric transistor-like barrier that is normally at work in the granules (anode tufts).

The Solar Transistor Model Explains

- Why coronal hotspots appear in the lower corona above sunspots.
- Why the corona changes shape from times of active to quiet Sun.
- The solar wind's flow rate depends on the voltage (energy) rise from the Sun's interior up to the photospheric tufts.
- The initial velocity (and temperature) of the solar wind ions depends on the voltage (energy) drop from the tufts down to the lower corona.
- That transistor action can cut off the solar wind flow.

The Solar Transistor Model

- Is an extension of Juergens' electric Sun model.
- Is additional evidence the ES model is valid.
- Small voltage variations control large current (flows) both in normal transistors and on the Sun.
- No other mechanism capable of controlling, varying, or completely cutting off the solar wind has yet been proposed.

Summary

An *electric circuit* is one that contains resistors, inductors, capacitors, sources, and perhaps transformers. An *electronic circuit* also contains *active elements* such as transistors that provide *amplification* of the signals (small variations in one variable producing large changes in another). The *Electric* Sun model pioneered by C. E. R. Bruce, Ralph Juergens, Wal Thornhill and indirectly by Hannes Alfvén is now extended to an *Electronic* Sun model via the analogy between its surface phenomena and the action of a junction transistor. The efficacy of a relatively weak voltage barrier in controlling large currents apparently occurs both in transistor circuits and also just above the surface of the Sun.

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[i] Juergens, R. The Photosphere: Is It The Top Or The Bottom Of The Phenomenon We Call The Sun?, *Kronos Vol. IV No. 4, 1979* http://www.kronos-press.com/juergens/1979-photosphere-juergens.pdf

[ii] http://www.st-andrews.ac.uk/~jcgl/Scots_Guide/intro/electron.htm

[iii] http://www.st-andrews.ac.uk/~jcgl/Scots_Guide/intro/electron.htm

[iv] http://www.st-andrews.ac.uk/~jcgl/Scots_Guide/intro/electron.htm