The Sun is an immense spherical ball of gravitationally bound plasma, generating copious fusion energy. The energy is emitted in all directions, mainly as electro-magnetic waves (light and heat). The Sun also emits about one-millionth as much energy in beams of energetic protons with accompanying electrons, called the Solar Wind.

One of the NASA/ESA big questions for satellite missions is "What heats the Solar Corona and energizes the Solar Wind?" Over the past 50 years, Solar Wind models have variously incorporated thermal energy, magnetic turbulence and weak electric fields, always beginning outside of the Sun itself.

Professor Charles Driscoll at UCSD has developed a new model which describes the electric fields arising from net charge inside the Sun, obtaining quantitative agreement with the NASA/ESA satellite Ulysses. The Ulysses data shows peak proton velocities approaching 880 km/s, corresponding to proton energies of 4000 electron-Volts. Moreover, this maximum is stable over decades, and constant over a wide range of heliocentric distances and latitudes, except near the ecliptic plane of the planets.

The electric model posits a net Solar charge displacement of 460 Coulombs, mainly located at the outer plasma edge. In simplest terms, this net positive charge occurs because electrons are continuously pushed outward by the enormous outflow of electro-magnetic energy, whereas the protons are not.

Significantly, this displaced charge is uniquely determined by a novel "virial limit", limiting the electric energy to the gravitational energy at the center of the Sun. At the solar surface, this determines the 4000 electron-Volts available to accelerate protons. The simple model then suggests that ecliptic gas and dust cause the intermittent, patchy "slow wind" which impacts the magnetosphere of Earth and displays as the colorful aurora Borealis.

Even given the requisite energy, significant questions remain as to the dynamics, uniformity, and constancy of the proton/electron beam generation. The electric model posits pervasive, persistent "proton lightning jets", analogous to Earth lightning. These appear as the glowing, ever-present "spicules", which densely cover the Solar surface. Moreover, these spatially distributed beams each constitute billions of Amperes, and so can readily create the patchy, fluctuating kilo-Gauss magnetic fields observed on the surface.

Intermittent surface currents can also create the intense surface flashes imaged by the Solar Orbiter satellite, which look distinctly like ground lightning propagation on Earth, in appropriately slow motion. Similarly, the electric model may provide description for the large flowing near-surface "prominences", which remain levitated for hours or days.

More importantly, the electric model may provide a basis for modelling extreme "space weather" events such as coronal mass ejections, in terms of large-scale collective potential variations and resultant currents near the Solar surface. This poses substantial challenges and opportunities for future theory and simulations.