The Sun releases charged particles into space via solar wind. The solar wind mainly contains electrons and protons, although it does have some heavier material from the Sun’s plasma, like carbon and nitrogen. Solar wind is also responsible for dragging part of the Sun’s magnetic field, called the heliospheric magnetic field, away from the Sun and into the Solar System. The solar wind exists because the particles in it come from the Sun’s corona, which has a high enough temperature that allows for the particles to escape the Sun’s gravity. The solar wind is divided into two states, fast wind and slow wind. Fast wind has speeds greater than 500 km/sec, while slow wind has speed less than 500 km/sec. There are also differences in the chemical composition of the two winds. Fast wind has a composition very similar to that of the Sun’s photosphere, and slow wind is similar to the corona.

How exactly the slow wind is created is still up for debate. Some argue that it comes from the edge of coronal holes, whereas fast winds come from the entirety of the coronal holes. The magnetic field expands rapidly here, which slows down the wind and changes the composition of the wind to be closer to the corona, resulting in a strong correlation between speed and composition. The issue with this theory is that this correlation hasn’t been observed to actually happen. The expansion factor slows the wind down, but this wind has the photospheric FIP ratios associated with fast winds.

A more likely theory is that slow winds come from the closed field corona. Closed field is the magnetic field lines that stay close to the Sun, not getting dragged out. The theory says that the plasma is released through the reconnection of open and closed magnetic field lines. An open field corridor connects two coronal holes, and the locations of the corridors can change from changes in the photosphere. This is from field lines opening and closing, which releases the closed field plasma. In magnetic reconnection, field lines travelling in opposite directions connect as they get closer and closer to each other. This forms quasi-separatrix layers. The QSL allows for slow winds to be located far from the heliospheric current sheet, which matches observed data.

People work on solar winds by playing with simulations and observed data. Magnetohydrodynamic equations in steady state were originally used to model the winds. People also create computer simulations to get plausible topological models. The models must fit with observed data from various solar probes like Ulysses, Voyager, and the Parker Solar Probe. Ulysses had an instrument called SWOOPS that detected electrons and ions to observe the wind. The Parker Solar Probe measures the electric and magnetic fields and also counts the electrons and ions.