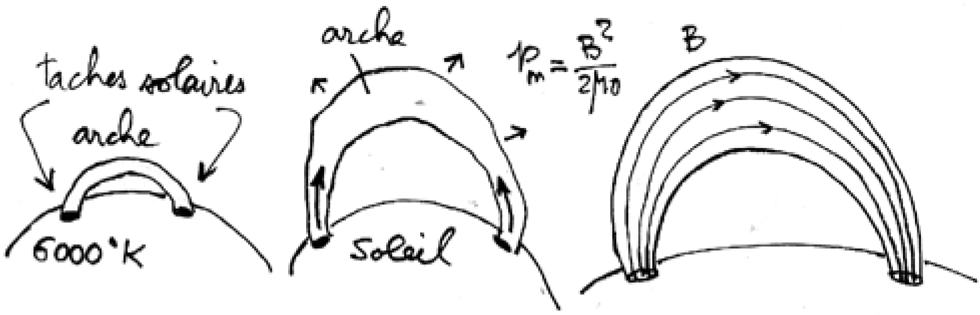
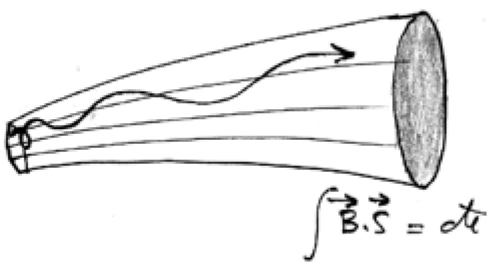
12 janvier 2001 I am being told, and I read here and there, that one doesn't know why the solar corona, the gaseous envelope of the sun, has a temperature which is in the order of one million degrees, whereas the surface is only 6000. This morning, an idea started emerging.

It is an observed fact: the sun periodically emits arches of plasma of a great amplitude. The anchoring points of these arches on the solar surface are the sunspots. The plasma surrounding the sun is in a condition, if I am not mistaken, of "a high number of magnetic Reynolds." This means that the magnetic fields are "frozen in" into the plasma. Imagine the hair of woman in a swimming pool and a comb going through them. The hair and the comb would be moving tightly together. One drags the other along, and reciprocally.



These plasma arches, it has been newly observed, spread over a great distance, then they dislocate. On the figure to the right, we have represented, schematically, the lines of the magnetic field. At any point in space, one can associate to the value B a corresponding value of "magnetic pressure," as indicated.

There is also the conservation of the magnetic flow:

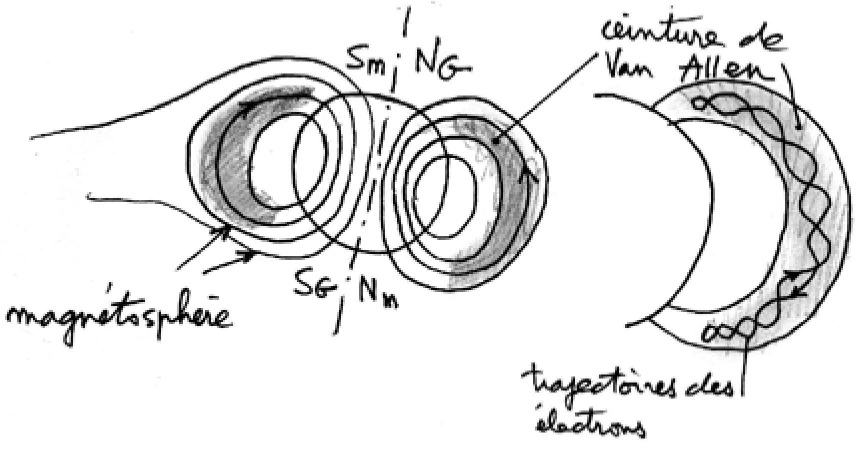


The value of the magnetic field is therefore at a maximum in the neighborhood of the sunspots and at a minimum at the point of maximal extension of the arch. The result is a gradient effect of the magnetic field. The arch is going to function as a natural accelerator of charged particles. Therefore, gas will peel off from the surface of the sun, from each sunspot, and propulsed by this gradient of the magnetic field, which is far superior to the force of gravity, it will rise and accelerate in order to reach the zone of minimal magnetic field, there, where the arch is largest and its section thickest. It would seem to me that then these masses of plasma could enter into collision. The result would be the conversion of magnetic energy (the energy which has served to accelerate the two plasma masses) into thermal energy. The following drawing illustrates this concept. Particle acceleration by means of a gradient of magnetic pressure, especially over very large distances, is a very effective process. One should be able to digitize and modelize all this more precisely, but I think that this phenomena could justify such a heating of the solar corona. We must not forget that, as the speed of thermal motion varies according to the square root of the temperature, the passage from 6,000 to one million degrees represents finally no more than a gain of factor 12 in the speed of thermal motion.

Having said this, where the plasma masses collide (the arches would then be the seat of magneto-acoustic phenomena very interesting to study) the pressure inside the plasma could become such that the plasma could escape the confinement of the bundle of magnetic field lines. Whence a dislocation of the arches, letting their burning content escape. Afterwards, one would have two scenarii: a moderate heating would feed the gaseous envelope of the sun, its corona. The gas which is at the surface of the sun would be pressed down on it. At 6,000 degrees, the speed of thermal motion is considerably weaker than the speed which a particle needs in order to appreciably get away from the sun. This is why the latter is fairly close to the shape of a sphere. But the more rapid particles, accelerated inside the arches, and then liberated when the arches dislocate, would then compose the "sun's atmosphere,' which extends at a much farther distance.

More violent solar eruptions (which are in fact *the secondary effect* of magnetohydrodynamic, MHD-, type instability with a high number of magnetics Reynolds) give us… the solar wind. We know otherwise that a high abundance of sunspots is synonymous with an intense bombardment of Earth by gases emitted by the Sun.

For those not specialized in plasma physics, this acceleration through a gradient effect of the magnetic field may be difficult to grasp. But many know about the Earth's « magnetosphere »:



Left, we have the terrestrial sphere, with its inclined magnetic dipole. By the way, the « magnetic North » of the Earth is in fact a South Pole, as it is attracting the North poles of magnet-compasses. The charged particles (mostly electrons) emitted by the Sun (the solar wind) find themselves trapped in the network of lines of the Earth's magnetic field. Figure to the right: they move back and forth between regions with an elevated field, spiraling around these lines of force. These spiral trajectories materialize so to speak the way that the plasma is tied in with the magnetic field. This plasma, which constitutes the « Van Allen belts, » named after the astrophysicist who discovered them, go back and forth between the Earth's polar North and South regions, the particles being kicked back and forth as if by tennis rackets (through the mere effect of the gradient of magnetic pressure). In physics, this is called a "magnetic mirror." To the left, the «train » of the terrestrial magnetosphere, in the direction opposite to the sun.

Under the normal regime, the charged particles reverse their path at a very high altitude, beyond the terrestrial atmosphere, the limit of which can be set at 80 km. When a particularly powerful whalloping of solar wind hits Earth, the particles, despite the braking effect due to the magnetic field gradient, manage to penetrate the upper reaches of the atmosphere and all astronomers know this to be the cause of the phenomenon of auroras. A Van Allen belt seems therefore to be a structure rather akin to these arches corresponding to solar eruptions, at least by some of its aspects.

All considered, maybe it's an idea I should dig in more. But there's so much to do......

Translated from the French by Anne-Marie de Grazia

Original note on Jean-Pierre Petit's website:

http://www.jp-petit.org/science/couronne_solaire/couronne_solaire.htm