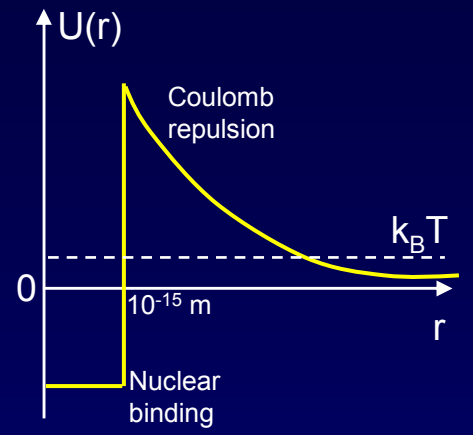
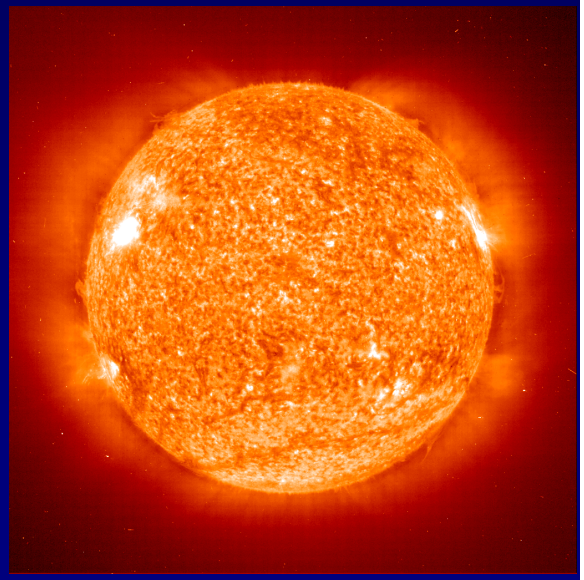
Tunneling Example: The Sun

The solar nuclear fusion process starts when two protons fuse together. In order for this reaction to proceed, the protons must "touch" (approach to within 10^{-15} m of each other).
The potential energy, U(r), looks something like this:



The temperature of the sun's core is $T \sim 1.3 \times 10^7$ K.
This corresponds to an average kinetic energy:
$k_BT = 2 \times 10^{-16}$ J (k_B = Boltzman's constant)
At r = 10^{-15} m the height of the Coulomb barrier is:

$U(r) = (1/4\pi\varepsilon_0)e^2/r = (9\times10^9)\times(1.6\times10^{-19}\ C)^2/10^{-15}\ m$
$= 2 \times 10^{-13}$ J



Thus, the protons in the sun very rarely have enough thermal energy to go over the Coulomb barrier.

How do they fuse then? By tunneling through the barrier!