

Under pressure (10 points).

Magnetic fields in the Sun are constantly shaping the structure of various different features in the Solar atmosphere. Inside any feature, the magnetic field (B) adds to the total pressure exerted by the gas. This so-called magnetic pressure is a function of the height z and can be expressed as:

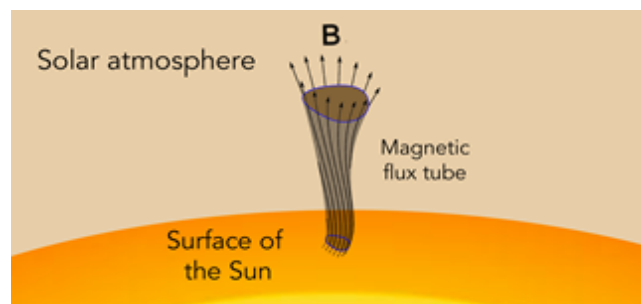
$$P_{mag}(z) = \frac{B^2(z)}{2\mu_0}$$

On the other hand, the gas can be considered to be in hydrostatic equilibrium and hence the gas pressure decays exponentially from an initial pressure value P_0 with increasing z . It can be expressed as,

$$P_{gas}(z) = P_0 e^{-z/H}$$

where H is the scale height, i.e. the height at which the pressure falls to $\frac{P_0}{e}$.

Consider one type of feature, a magnetic flux tube rising from the Solar surface up into an unmagnetized environment (see Figure below). Assuming that the total pressure of the material inside the tube and of the material outside it is in equilibrium,



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| 5.1 | Find an expression for the magnetic field strength as a function of height z . | 7.0pt |
| 5.2 | If the magnetic field at the base of a flux tube is $0.3T$, and scale height H in a given solar model is 150 km , at what height will the magnetic field be reduced to $0.03T$? | 3.0pt |