MAGNETIC POLARIZATION (a.k.a. MAGNETIZATION)

Here is an unmagnetized lump, say an iron filing:
How does it respond to an external applied field?

1. First let's sketch the applied field without the lump present:

N → S

Fig. 1

The field lines are uniformly separated, indicating a constant magnetic (B) field.

2. Here is the extra (new) field induced when the lump is placed in the applied field:

N → S

Fig. 2

Note appearance of poles (N & S). This type of field is a "dipole". For small \( \mathbf{B} \), its overall strength is \( \mathbf{M} = \chi \mathbf{B} \), where \( \chi \) is the lump's "susceptibility".

\( \chi \) is huge for iron (a ferromagnet), but small ( & sometimes negative ) for most other materials.

3. The total (actual) \( \mathbf{B} \) field is the sum of the above two pictures:

N → S

Fig. 3

Note the two high-field regions where the field lines come closest together.

4. Calculating the energy shows that a 2nd lump would be attracted to these high-field regions, explaining the tendency to "chain together" in an applied field:

5. Because of microscopic domain flipping, iron usually retains residual magnetization (like Fig. 2) even after removing any applied field.

• These all provide fruitful analogies for humans in the external media environment.