Transformed E&M I materials

Field of Magnetized Object (Bound Current)
(Griffiths Chapter 5)

STUDENT DIFFICULTIES

Notes
One student asked a very good question – when we are calculating A inside an object (eg., #6.8), then why do we not use a surface current K? When you are sitting at any point inside the object, there are "dangling" surface dipoles which are not cancelled by the ones above them (since you're not including those in the enclosed current).

Common difficulties

Bound vs. free current

- Many students struggled to recognize that $\int B \bullet dl = total\ I_{enclosed}$, where *total* $I_{enc} = I_{free} + I_{bound}$, which includes both free and bound current.
- I see evidence that the physical interpretation of bound charge didn't stick with some students; they are now having trouble with bound current.
- There was some difficulty in knowing (a) what the direction of B was if you have bound currents and (b) how to calculate B using bound currents.
- Griffiths mentions briefly that if there is no free current flowing through the linear medium, then the bound volume current is zero. However, this isn't obvious and in one problem (6.16) I was not able to reason through the physical situation.
- When calculating K_b (such as problem 6.16) you need to be careful of the surface you are using. If the surface is that of a cavity inside a material, then the normal to that cavity actually points inwards, and this can trip students up.

Magnetism M

- When calculating the magnetism for a thick wire from $M = \chi_m H$ (Griffiths 6.17), the question arose whether to use B_{in} or B_{out} to calculate M. They figured out that it was B_{in} because you're looking at the material, but this seems to suggest a slight uneasiness in going between the physical situation and the math.
- In 6.16 the magnetism M is in the ϕ direction, and so we tried to figure out whether the bound current J_b was zero or not by our physical intuition. It turns out that when you calculate ∇XM in cylindrical coordinates, you get zero, but it's not obvious to me why this is. It "looks" curly.