

Transformed E&M I materials

Magnetic Vector Potential (Griffiths Chapter 5)

STUDENT DIFFICULTIES

Notes

- How does A make our lives any easier? It does not have a direct connection to energy, like V does. It's useful for separation of variables and multipole expansions.
- When do we use A to get B and when can we get B directly? Biot-Savart is hard to use, and there are few problems that are solvable using Ampere's law, so A is a mathematical shortcut to get to the physics. We have a lot of tricks for calculating V , and we can use those same tricks for A , just in 3 dimensions. A will also be useful in radiation and modern physics, and has application to Shroedinger equation.
- We have a few articles on the vector potential available.

Common difficulties

What is A ? (*)**

- There is a general consensus that A is an opaque quantity – students don't know why it's useful or what it represents. When do we use A and when is it easier to use B ?
- The analogy between B and A , and J and B is very tricky for students.

Vector calculus (*)**

- Vector calculus problems arise at this point in the course because of some of the mathematical formalism required.
- On the homework in the Traditional course they were asked to do some vector calculus operations in order to verify the curl of $A = B$ and some other relations (#5.27). Many people did poorly on this, and did not give reasoning for most of their mathematical steps. There was an overall impression that they did not understand the vector calculus and could not make the connection between the mathematical operations and the physics of the operations.
- There was also a tendency to be sloppy about whether a particular vector operator was operating on a particular vector (eg., ∇ not operating on primed coordinates), but this was not observed in the Transformed course where most knew that a non-primed operator operating on primed coordinates would be zero.

- In the Transformed course, vector calculus problems also cropped up around this time, such as uncertainty about how to do the integral of a vector where there are three components inside the integral. Another question that came up several times was when can you move a derivative outside of an integral (HW10, Q2).

Magnetic dipoles (*)**

- By the end of the course, most students don't see a current loop as a magnetic dipole, and when asked the best method to find B of a current loop when far away, most answer by direct integration.