Subject: Re: Are the field lines the trajectory of a particle with mass M?
Posted by James Kuyper on Sun, 14 Mar 2004 16:01:51 GMT
View Forum Message <> Reply to Message

pakachunka wrote:
>
> I believe the field lines are not the trajectories... but a friend of
> mine is driving me crazy, because he says they are.
>
> How can I demonstrate that field lines are not the trajectories?
>
> I mean: what are field lines, to start?

Your question is too broad. There are many kinds of fields. Field lines are associated with vector fields. A typical vector field may be described by a vector-valued function v(x,y,z,t), which means it has a single size and direction for every meaningful combination of x,y,z, and t. Field lines are lines associated with a vector field that are arranged so that at every point, the tangent to the line at that point is in the same direction as the vector field at that point. In other words, the vector field tells the lines where to go.

Now, if the two of your are talking about the velocity field of a fluid, then the field lines are indeed exactly the trajectories of the individual particles that make up the fluid.

However, fluid dynamics is fairly complicated, and your question gives the impression that you're at a fairly elementary level in physics. In that case, the fields you're most likely to run into aren't velocity fields, but electrical or gravitational fields. For example, the electrical field in the vicinity of a particle with charge Q, at a position <x0,y0,z0> has an associated static electrical field at a point <x,y,z> which is given by

$$E(x,y,z) = kQ\langle x-x0, y-y0, z-z0\rangle / r^2$$

where $r^2=(x-x0)^2+(y-y0)^2+(z-z0)^2$.

The important thing is that the electrical field is NOT a velocity field, and therefore the field lines are not in general the same as the particle trajectories. If the electrical field provides the only force that is acting on a particle with a charge of q and a mass of m, then it will feel an acceleration of Eq/m. Acceleration is not velocity, it's the first derivative of the velocity. There's a connection between the electrical field lines and the trajectories of the particals, but it's not a simple one.