Math 1800 Project 10: Flux Diagrams*

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A *flux diagram* uses flow lines to represent a vector field. The arrows drawn on a flow line indicate the direction of the vector field. The flow lines are drawn in such a way that their density is proportional to the magnitude of the vector field at each point. (The density is the number of flow lines per unit length along a curve perpendicular to the vector field.)

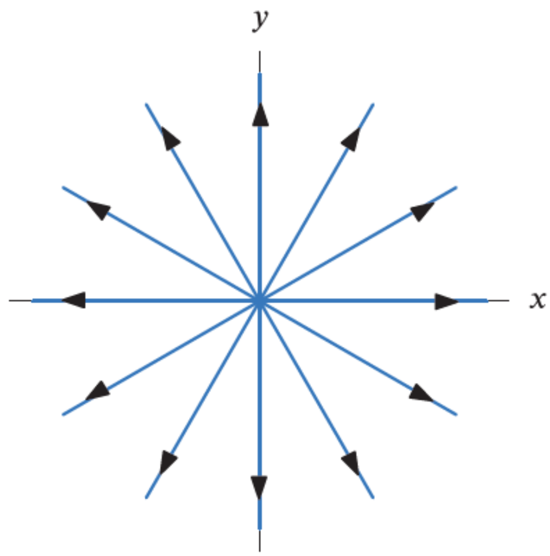

Figure 1

Figure 1 is a flux diagram for the vector field in 2-space $\vec{F} = \dfrac{\vec{r}}{||\vec{r}||^2}$. Since the field points radially away from the origin, the flow lines are straight lines radiating from the origin. The number of flow lines passing through any circle centered at the origin is a constant k. Therefore, the flow lines passing through a small circle are more densely packed than those passing through a large circle, indicating that the magnitude of the vector field decreases as we move away from the origin. In fact,

$$\text{Density of lines} = \frac{\text{Number of lines passing through circle}}{\text{Circumference of circle}} = \frac{k}{2\pi r} = \frac{k}{2\pi} 1/r,$$

so that the density is proportional to $1/r$, the magnitude of the field.

Sometimes we have to start new lines to make the density proportional to the magnitude. For example, the flow lines of $\vec{v} = x\hat{i}$ are horizontal straight lines directed away from the y-axis. However, since the magnitude of $\vec{v}$ increases linearly with x, we have to make the density of lines increase linearly with x. We achieve this by starting new lines at regular intervals. (See Figure 2.)

*Source: Hughes-Hallett

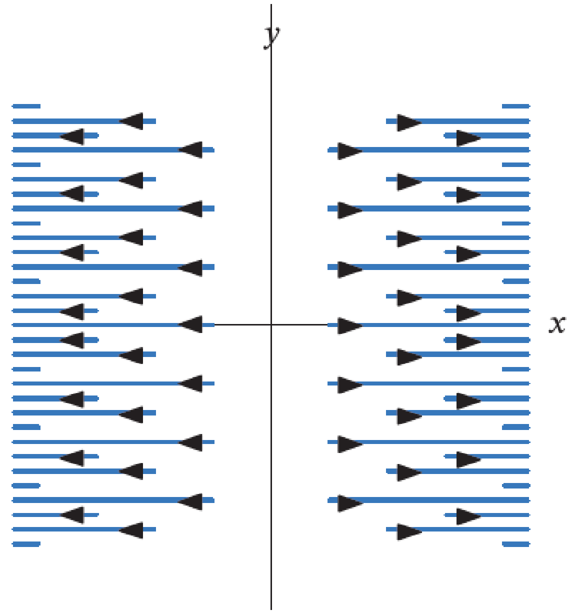

Figure 2

Draw flux diagrams for the following vector fields:

(a) $\vec{v} = \hat{\imath}$

(b) $\vec{v} = -y\hat{\imath} + x\hat{\jmath}$

(c) $\vec{v} = y\hat{\imath}$

(d) $\vec{v} = y\hat{\jmath}$