SURFACE AND VOLUME CURRENT DENSITY 2

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Reference: Griffiths, David J. (2007) Introduction to Electrodynamics, 3rd Edition; Prentice Hall - Problem 5.6.

A couple more examples of surface and volume current.

Given a disk with a uniform surface charge density σ rotating at angular speed ω, its linear speed at a point r from the centre is $v = \omega r$, so its surface current is

$$K = \sigma \omega r \tag{1}$$

Now consider a uniformly charged sphere with density ρ spinning about its axis with angular speed ω. If we centre a spherical coordinate system at the centre of the sphere and align the axis of rotation with the z axis, then a point at location (r, θ, ϕ) has linear speed $r\omega \sin\theta$, so the volume current density is

$$J = \rho r \omega \sin\theta \tag{2}$$