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Solid Angle (spacial direction)

Solid Angle (rotational measurement of spherical direction): <sup>1</sup>

$$\Omega = \frac{A}{R^2} = \int_A \frac{\cos(\varepsilon)}{R^2} dA \quad \in [0, 4\pi] \quad (1)$$

where  $A \equiv$  spherical Area,  $R \equiv$  spherical Radius (radial distance), and  $\varepsilon = d\vec{A} \cdot \vec{e}_n = \angle(dA, R)$  inclination angle of  $dA$  to  $R$  along the curved surface  $A$

$$dA = \frac{R^2}{\cos(\varepsilon)} \sin(\theta) d\theta d\varphi = \frac{R^2}{\cos(\varepsilon)} d\Omega \quad (2)$$

where  $\varphi \equiv$  horizontal angle,  $\theta \equiv$  vertical angle

Symmetry of wave propagation from electromagnetic radiation in vacuum (Reversibility of Beam according

$$d\Omega_g = \frac{\mathcal{M}}{\mathcal{J}} dA_g = \frac{dA_b}{R} \frac{\cos(\varepsilon_b)}{R} = \frac{dA_b \cos(\varepsilon_b)}{R^2} \quad (3)$$

$$d\Omega_b = \frac{\mathcal{M}}{\mathcal{J}} dA_b = \frac{dA_g}{R} \frac{\cos(\varepsilon_g)}{R} = \frac{dA_g \cos(\varepsilon_g)}{R^2} \quad (4)$$

$$d\Omega = \sin(\theta) d\theta d\varphi = \frac{dA_{\perp}}{R^2} = \frac{\cos(\varepsilon)}{R^2} dA = \mathcal{J} \cdot d\Omega_g = \mathcal{M} \cdot dA_g = \mathcal{J} \cdot \mathcal{M}_b \cdot \frac{\varepsilon_b}{R^2} \quad (5)$$

where  $\mathcal{J} \equiv$  Flux Density,  $\mathcal{M} \equiv$  Radiant Exitance

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<sup>1</sup> $[\Omega] = [sr]$  Steradian, "Raumwinkel"