Why flatter is better for the Alcubierre Drive

$$\mathrm{d}s^2 = -c^2\mathrm{d}t^2 + (\mathrm{d}x - f(r_s)v_s\mathrm{d}t)^2 + \mathrm{d}y^2 + \mathrm{d}z^2$$

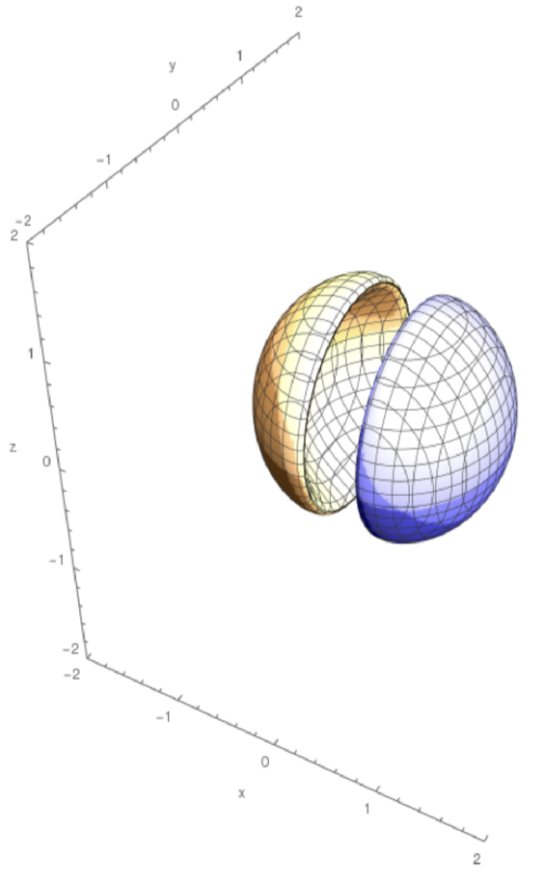
Cylindrical Coordinates: $f(r_s) \longrightarrow f(x - x_s, \rho)$

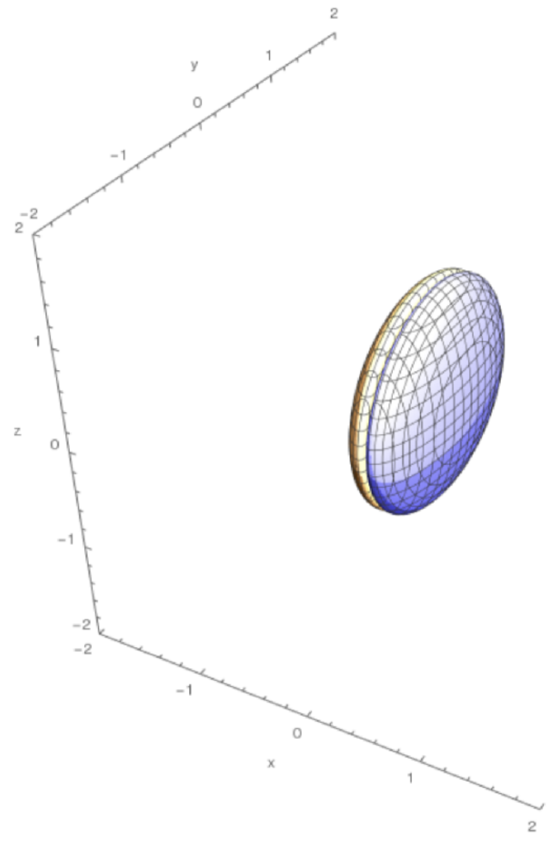
Generally-shaped Alcubierre drive

New energy density: $T^{00} = -\frac{1}{4} f_\rho'^{\,2} v_s^2 \longrightarrow T^{00} = -\frac{f_r'^{\,2}\rho^2}{4r_s^2} v_s^2$

Optimized shape function:

$$\bar{f}(\rho) = A \ln \rho + B$$





APPLIED PHYSICS

Connecting Existing Metrics to the General Definition

Alcubierre: $$\mathrm{d}s^2 = -c^2\mathrm{d}t^2 + (\mathrm{d}x - f(r_s)v_s\mathrm{d}t)^2 + \mathrm{d}y^2 + \mathrm{d}z^2$$

Inside: $$f = 1 \quad \mathrm{d}s^2 = -c^2\mathrm{d}t_{\mathrm{loc}}^2 + \mathrm{d}x_{\mathrm{loc}}^2 + \mathrm{d}y_{\mathrm{loc}}^2 + \mathrm{d}z_{\mathrm{loc}}^2$$

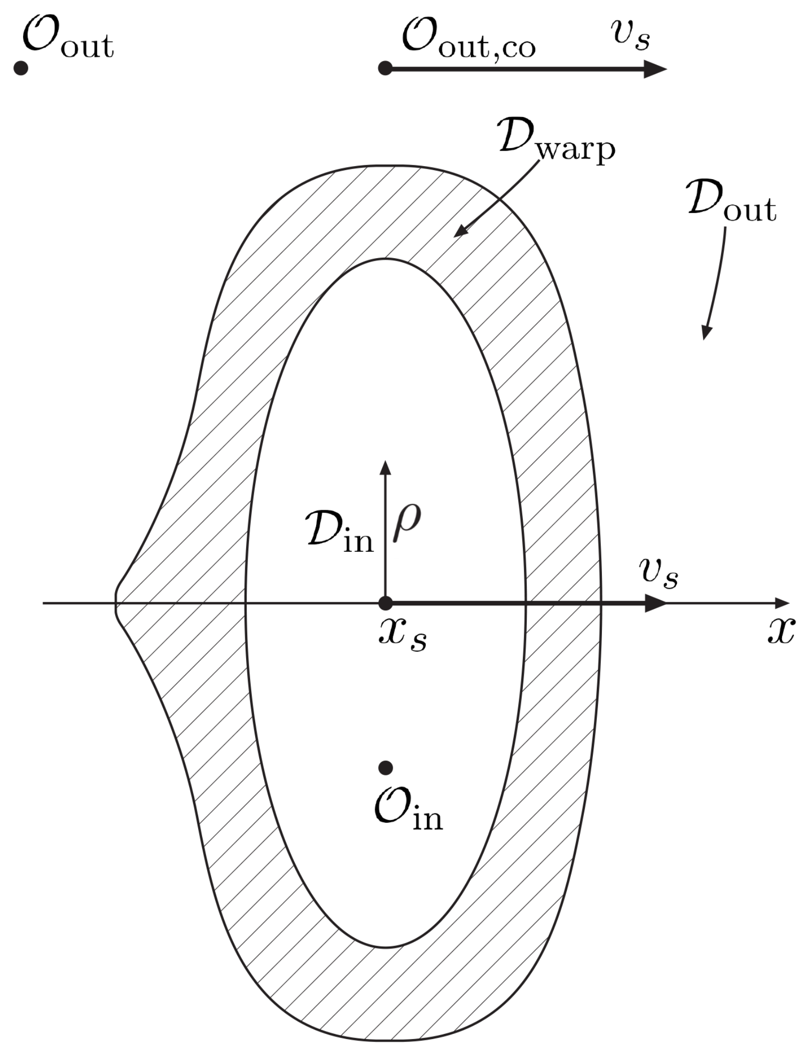
Outside: $$f = 0 \quad \mathrm{d}s^2 = -c^2\mathrm{d}t_{\infty}^2 + \mathrm{d}x_{\infty}^2 + \mathrm{d}y_{\infty}^2 + \mathrm{d}z_{\infty}^2$$

Coordinates:

$$\mathrm{d}t_{\mathrm{loc}} = \mathrm{d}t = \mathrm{d}t_{\infty}$$
$$\mathrm{d}x_{\mathrm{loc}} = \mathrm{d}(x_{\infty} - x_s(t_{\infty}))$$

Class I or III

$$\mathrm{d}y_{\mathrm{loc}} = \mathrm{d}y = \mathrm{d}y_{\infty}$$
$$\mathrm{d}z_{\mathrm{loc}} = \mathrm{d}z = \mathrm{d}z_{\infty}$$



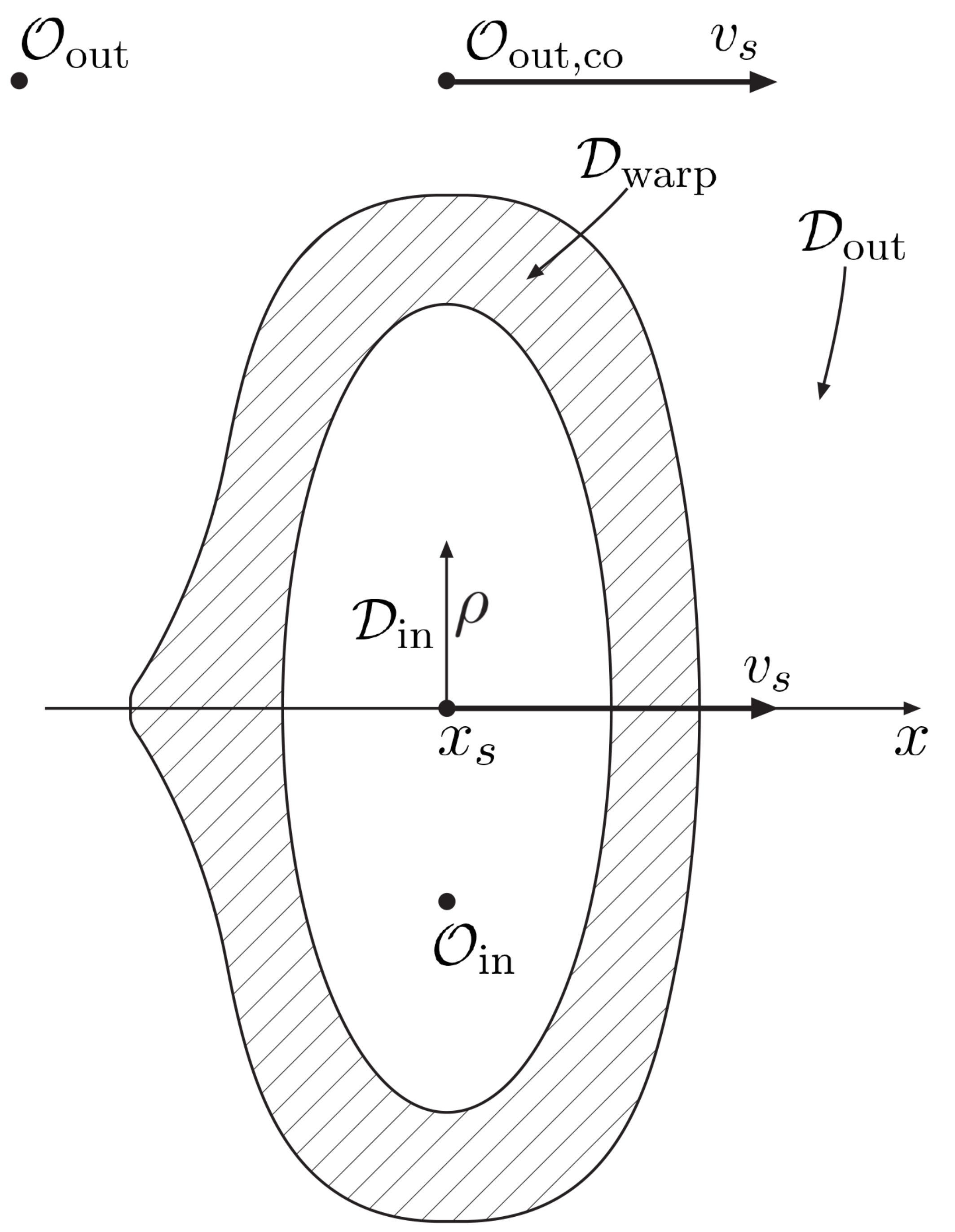
APPLIED PHYSICS

Generating New Classes

When Generalised:

$$\mathrm{d}s^2 = -c^2\mathrm{d}t_\infty^2 + (\mathrm{d}x_\infty(1-f) + f\mathrm{d}x_{\mathrm{loc}})^2 + \mathrm{d}y_\infty^2 + \mathrm{d}z_\infty^2$$

$$x_{\mathrm{loc}} = x_{\mathrm{loc}}(x_\infty, t_\infty)$$



- **Same possible for other coordinates**
- **With individual shape functions**

Can choose/control the internal spacetime!

APPLIED PHYSICS

What is a Warp Drive?

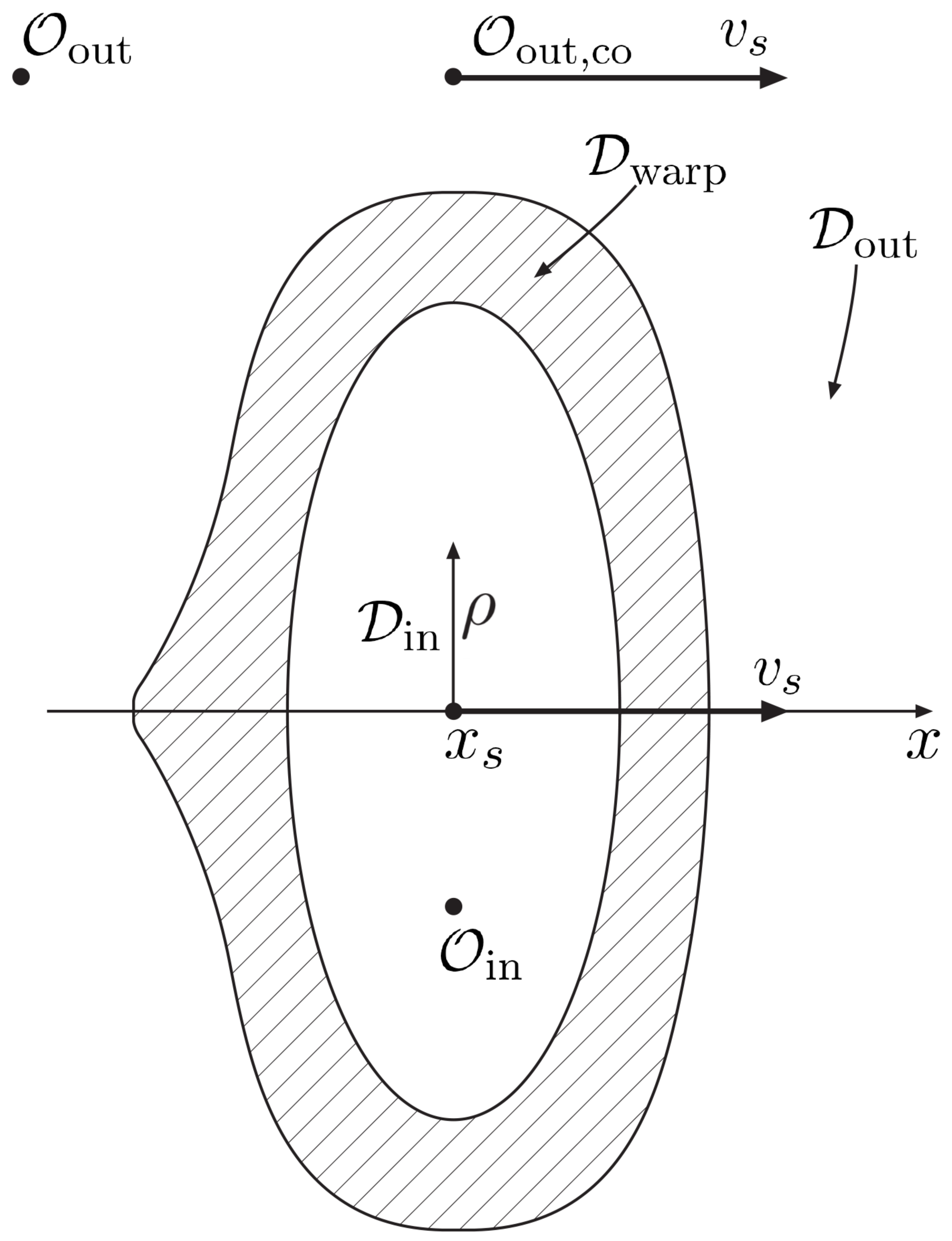


Figure from Bobrick & Martire, 2021

APPLIED PHYSICS