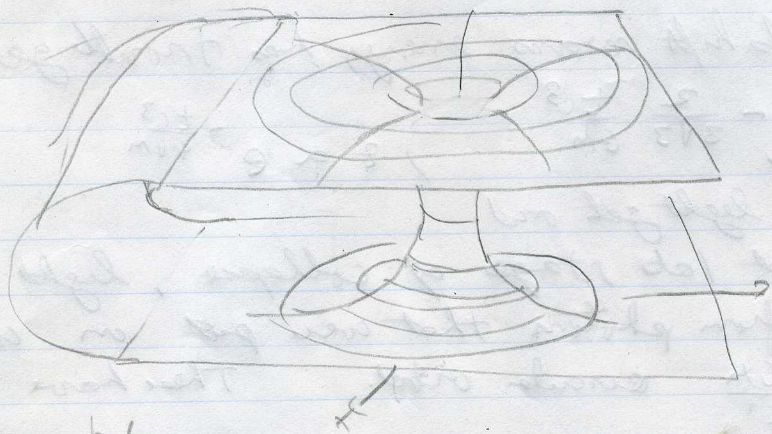
Use embedding at a fixed time $t = v = 0$



Schwarzschild wormhole,
Throught, Einstein-Rosen bridge.

radial Null geodesics $ds = 0$ give $d\theta = d\phi = 0$ $ds = 0 \Rightarrow$

$dv = \pm du$

or 45° angle everywhere. Lightcones are all like SR. No flop over or squeeze-up.

$r = 0$

$\Rightarrow u = sh\left(\frac{tc^3}{2GM}\right)$

$v = ch\left(\frac{tc^3}{2GM}\right)$

$ch^2 - sh^2 = 1$

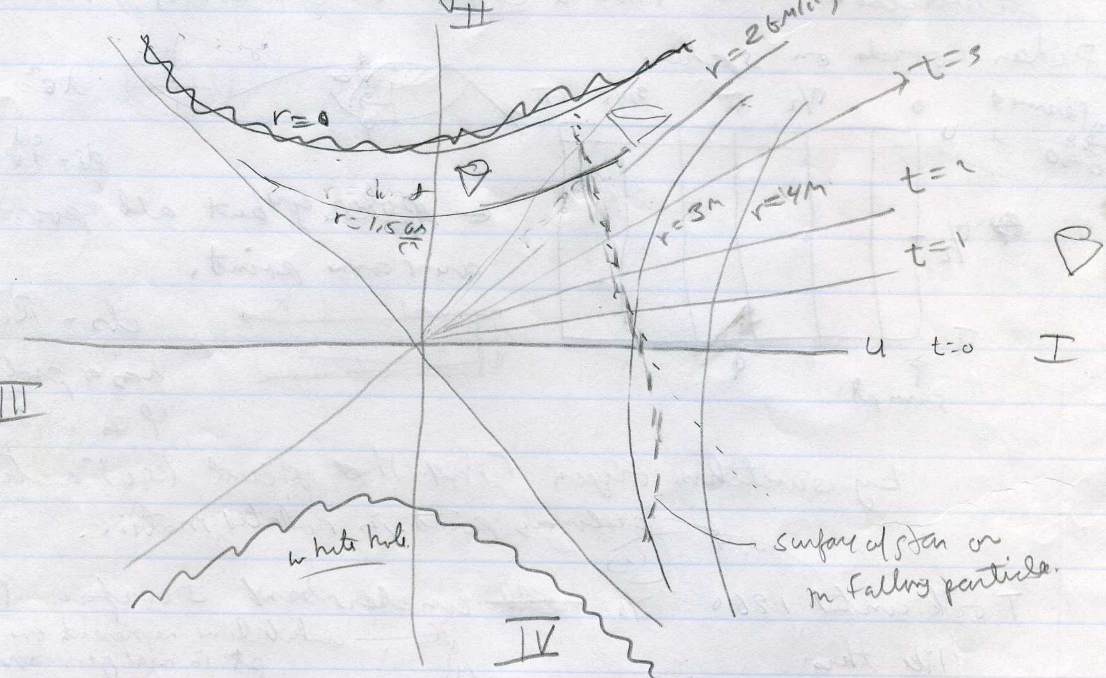
$v^2 - u^2 = 1$

$\underline{\text{hyperbola}}$

= singularity

$t = t_0$

$\frac{u}{v} = th$ = const with time



- photons travel at 45° angle
- hyperbola of constant r (not moving)
- lines of constant t   ($u^2 - v^2$ depends only on r ⇒ t advances along these hyperbolas)
- for $r < 2M$ hyperbolas switch, & particle must hit $r = 0$ $\boxed{\frac{u}{v} = \tanh\frac{t}{4GM} \text{ inside},\ \coth\frac{t}{4GM} \text{ outside}}$
- $r = 0$ is not a pt but a surface. -
- after $t = \infty$, can't get out.
- horizon is a null line
- 4 regions
- dashed is collapsing star, I and II are physical, III could be "white hole"!!
- region II connection (wormhole) to another Universe!!
- upward curves are V4 timelike ⟷ spacelike.
- max lifetime is $\tau = 1.54 \times 10^{-5} \frac{M}{M_\odot}$ seconds $\begin{cases} M = 10^9 \Rightarrow \tau = 4 \text{ hours} \\ M = 10^{15} \Rightarrow 15 \text{ billion} = \text{age of Universe!!} \end{cases}$ ≈ mass of U!!