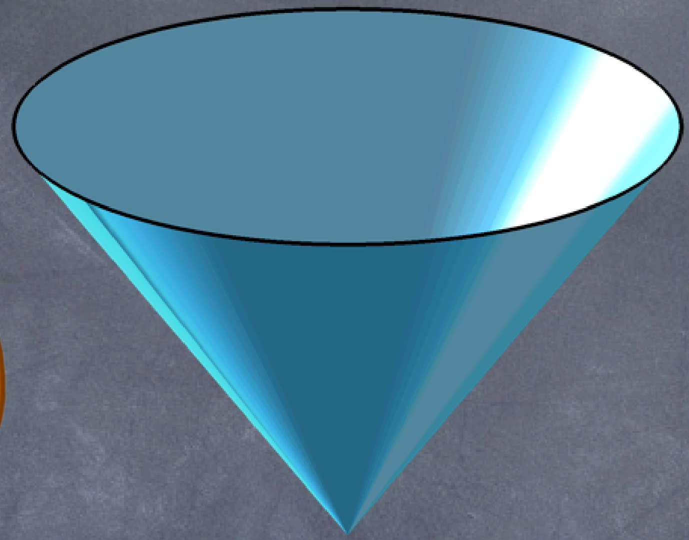
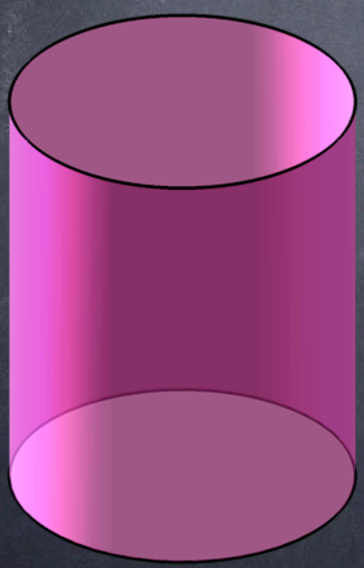
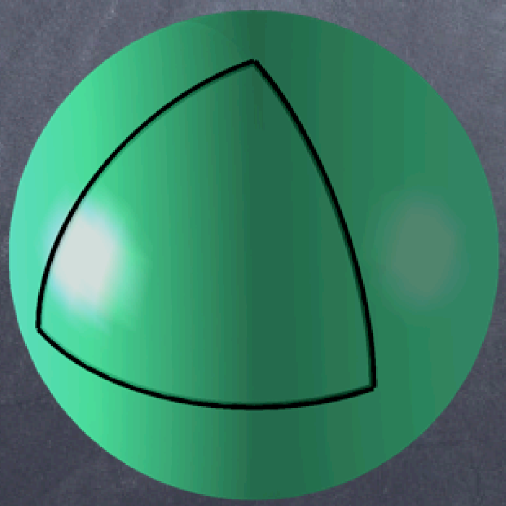
Intrinsic and extrinsic curvature



Intrinsic curvature measured by the Riemann tensor

$$R_{abc}{}^{d}$$



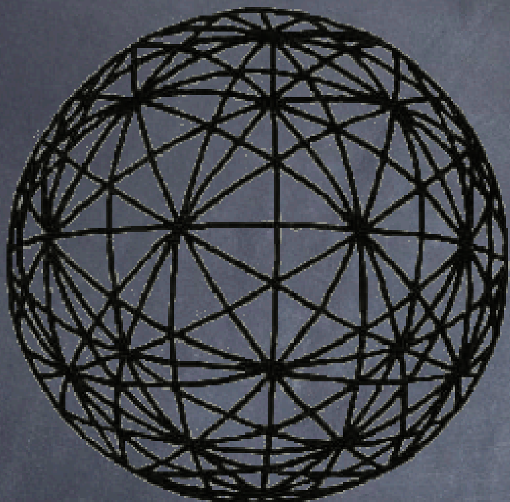


Dimension of $R_{abc}{}^{d}$

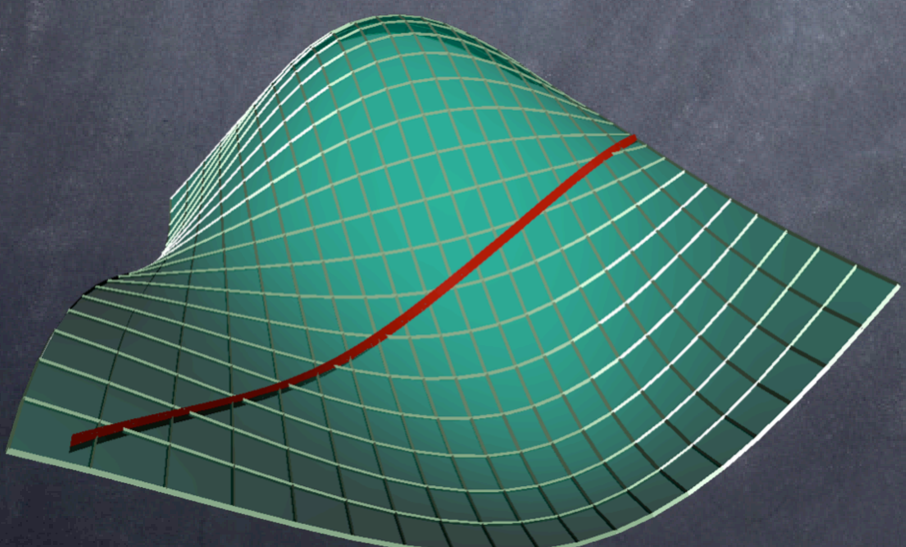
1-D	0
2-D	1
3-D	6
4-D	20

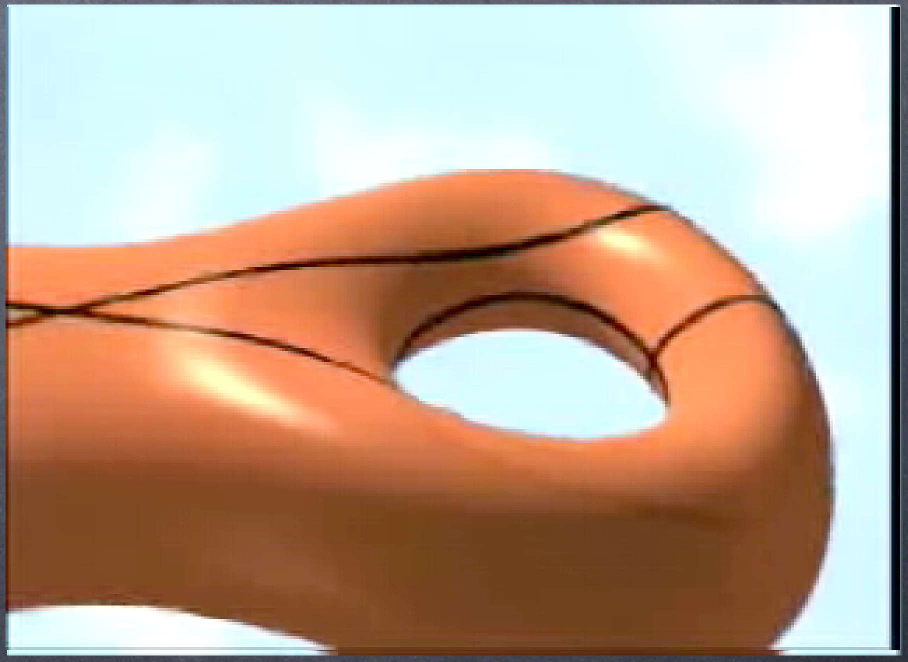
Geodesics

Straight lines through curved space



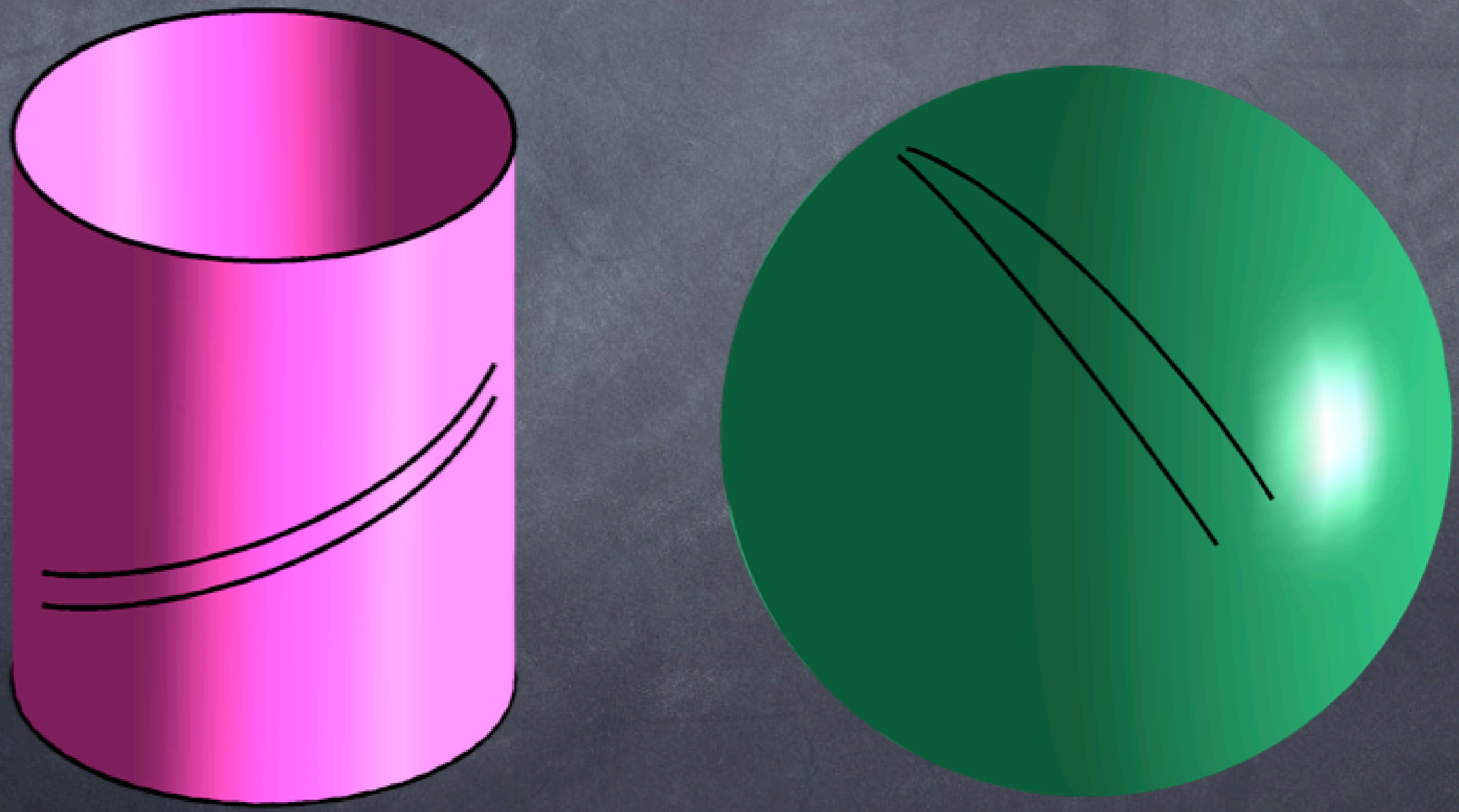
Objects in free fall move on the straightest possible paths through curved spacetime



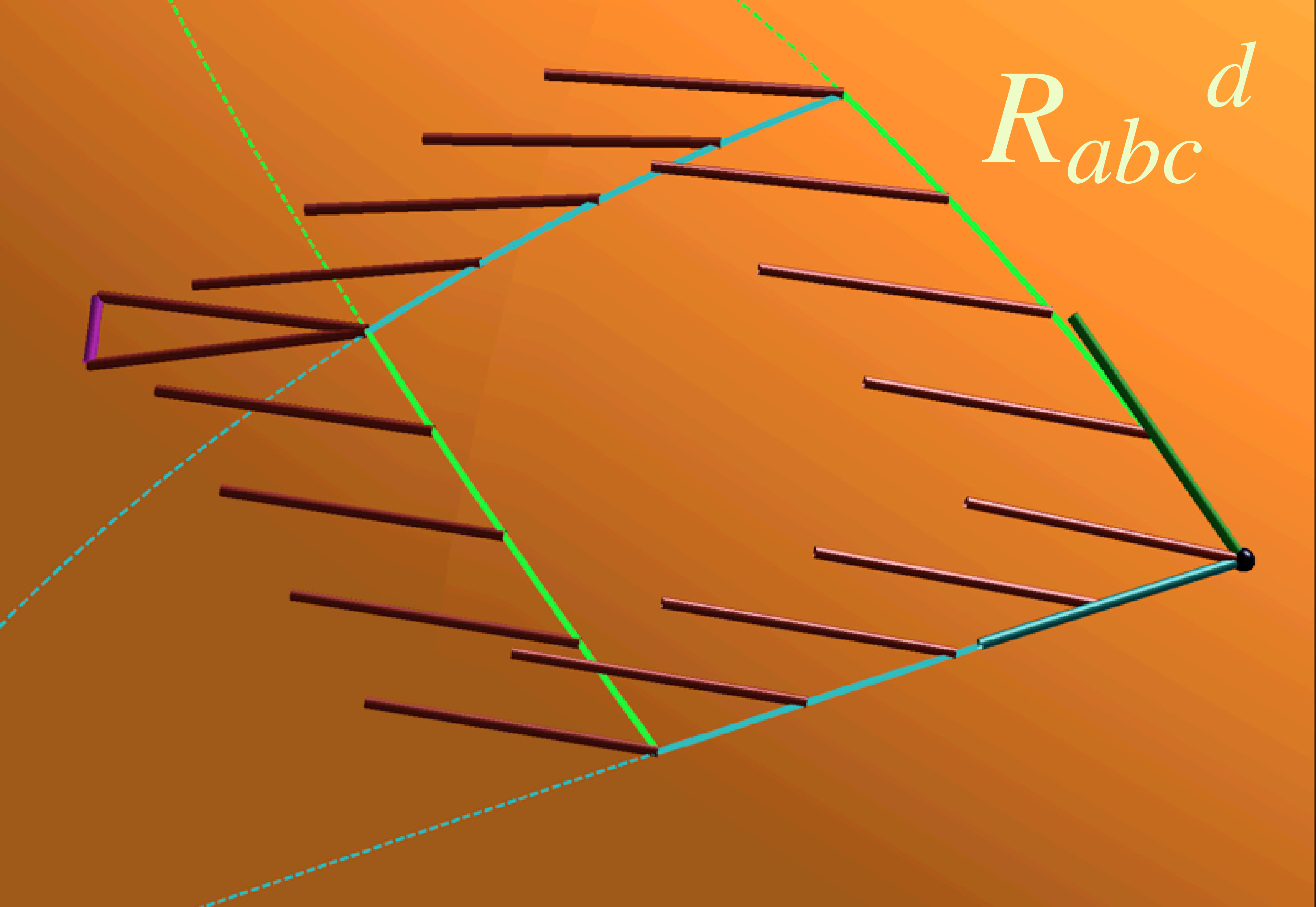


Geodesic deviation

Spreading or convergence of parallel geodesics can be used to measure intrinsic curvature.



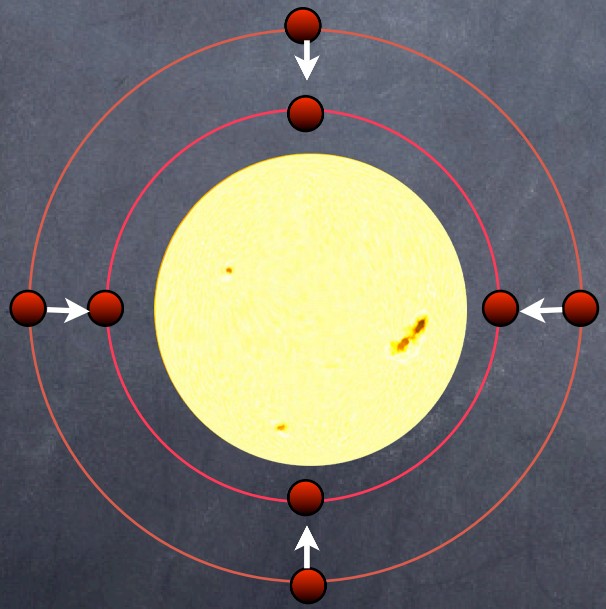
Riemann curvature tensor

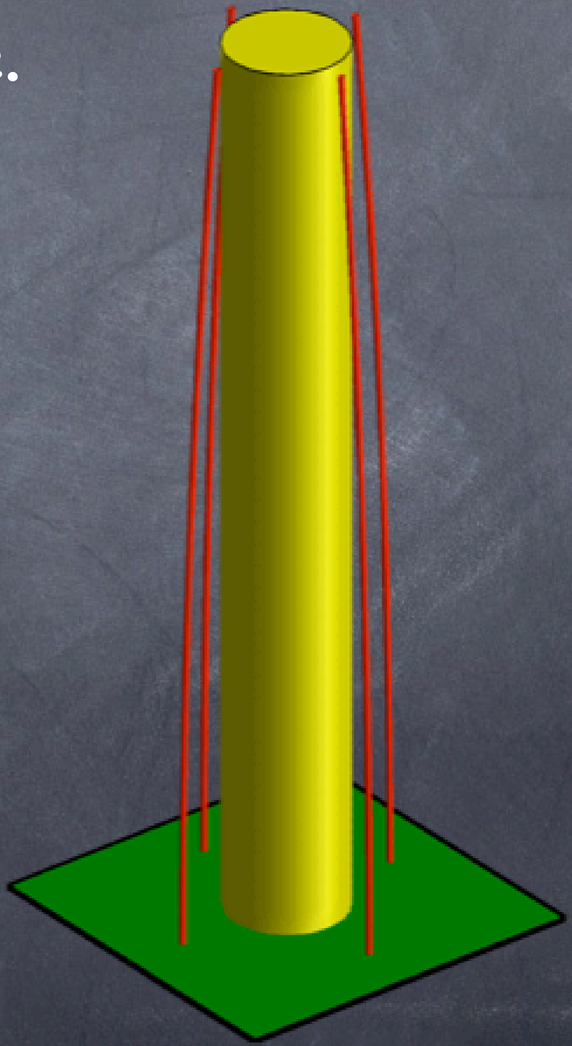


Ricci curvature

$$R_{ab} = R_{adb}{}^{d}$$

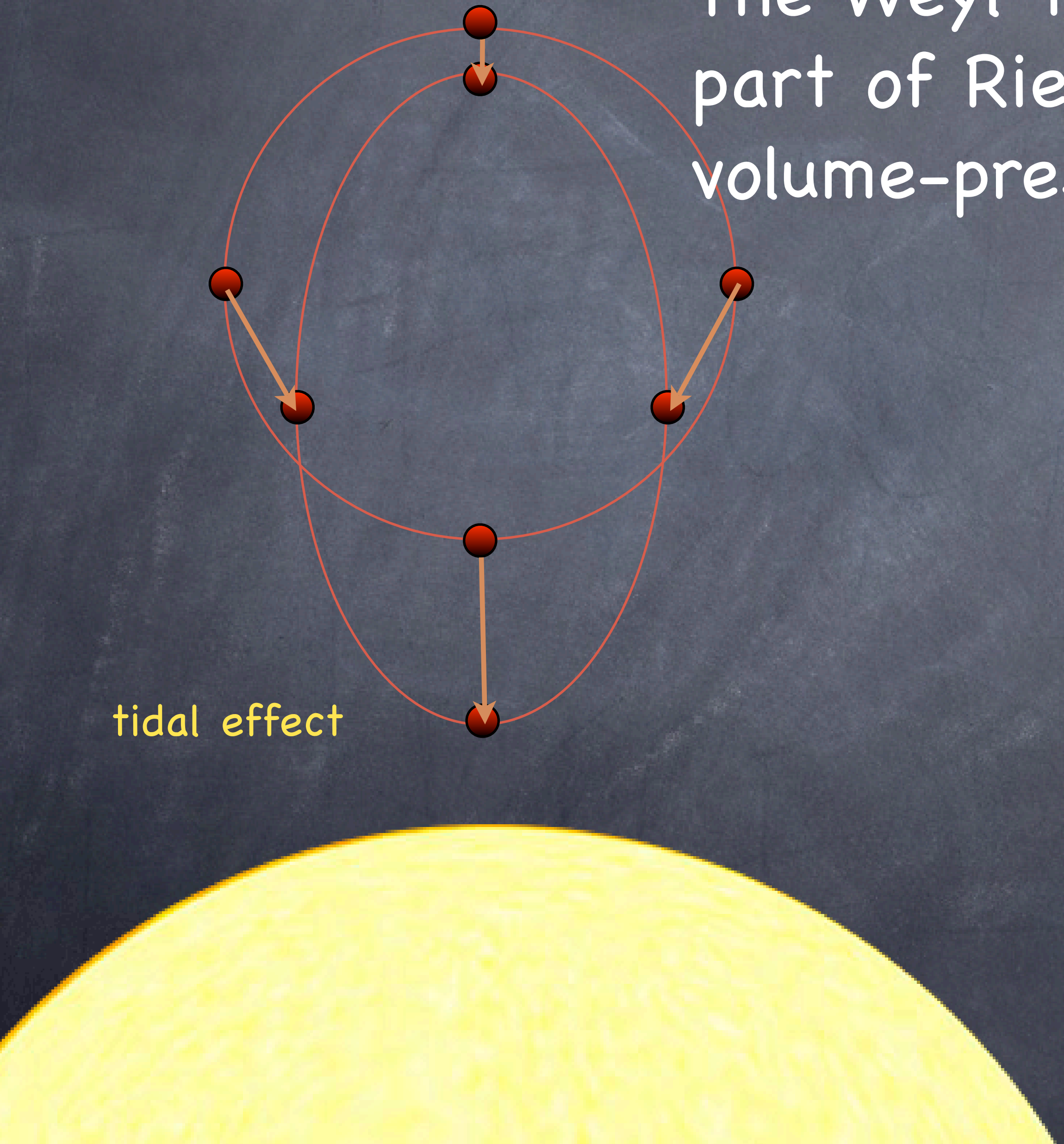
Ricci curvature is the trace of the Riemann tensor, the part responsible for volume change.

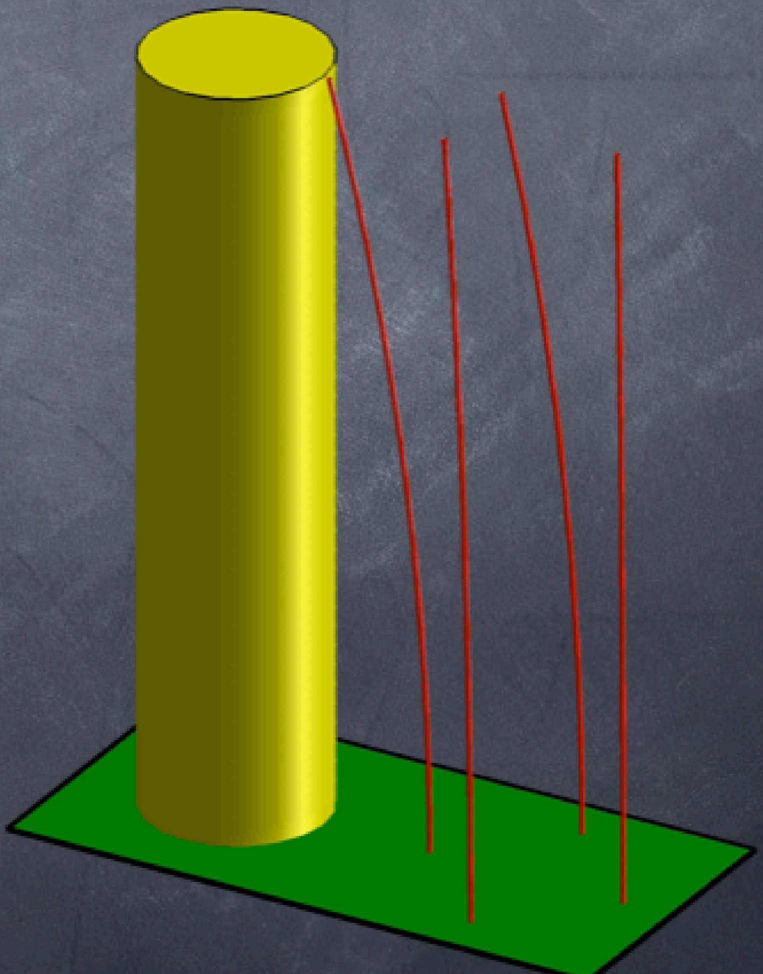




Weyl curvature

The Weyl tensor is the trace-free part of Riemann, responsible for volume-preserving shape distortion.





Einstein's field equations

$$R_{ab} = kT_{ab}$$

Mass-energy tensor,
comes from a matter model,
vanishes for vacuum

almost...

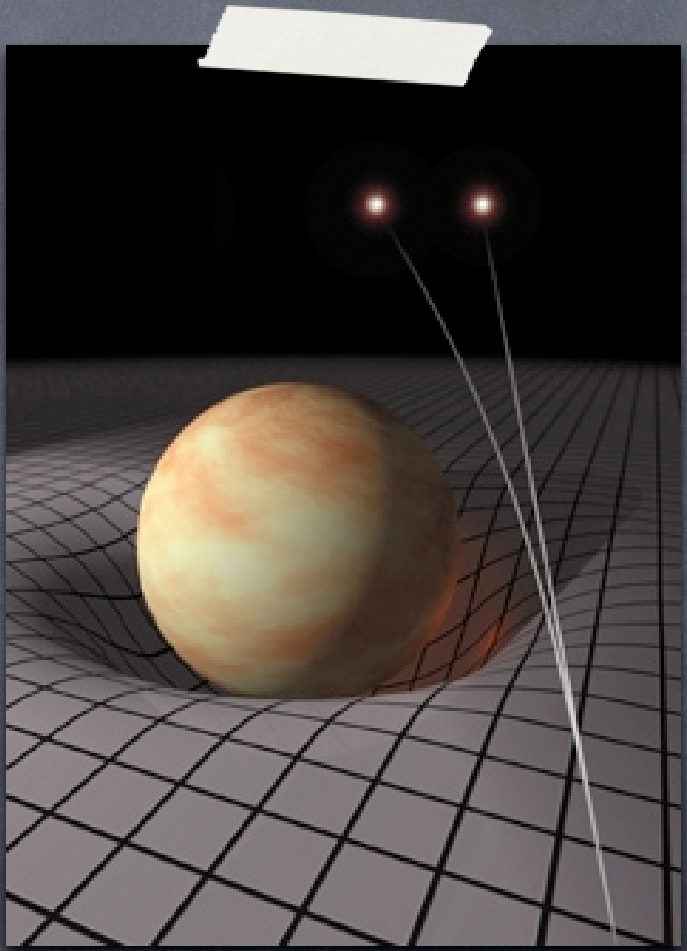
Einstein's field equations

$$G_{ab} = kT_{ab}$$

$$R_{ab} - \frac{1}{2} R\, g_{ab},\ R = R^a_a$$

$$\frac{8\pi G}{c^4} = 2 \times 10^{-48} \mathrm{sec}^2/\mathrm{g\ cm}$$

Spacetime grips mass, telling it how to move; mass grips spacetime, telling it how to curve.



- John Archibald Wheeler