

PS #4 pls hand in  
ON CHAIRS

$$(d\tau)^2 = \frac{(dr)^2}{(1 - \frac{r_{Sch}}{r})} + r^2(d\Omega)^2 - c^2(1 - \frac{R_s}{r})(dt)^2$$

r is a coordinate  
 $R_s = 2GM/c^2$   
 $\alpha, \theta, \phi, t$

object of M,  $R_o \rightarrow$  radius of object

black hole:  $R_o < R_s$

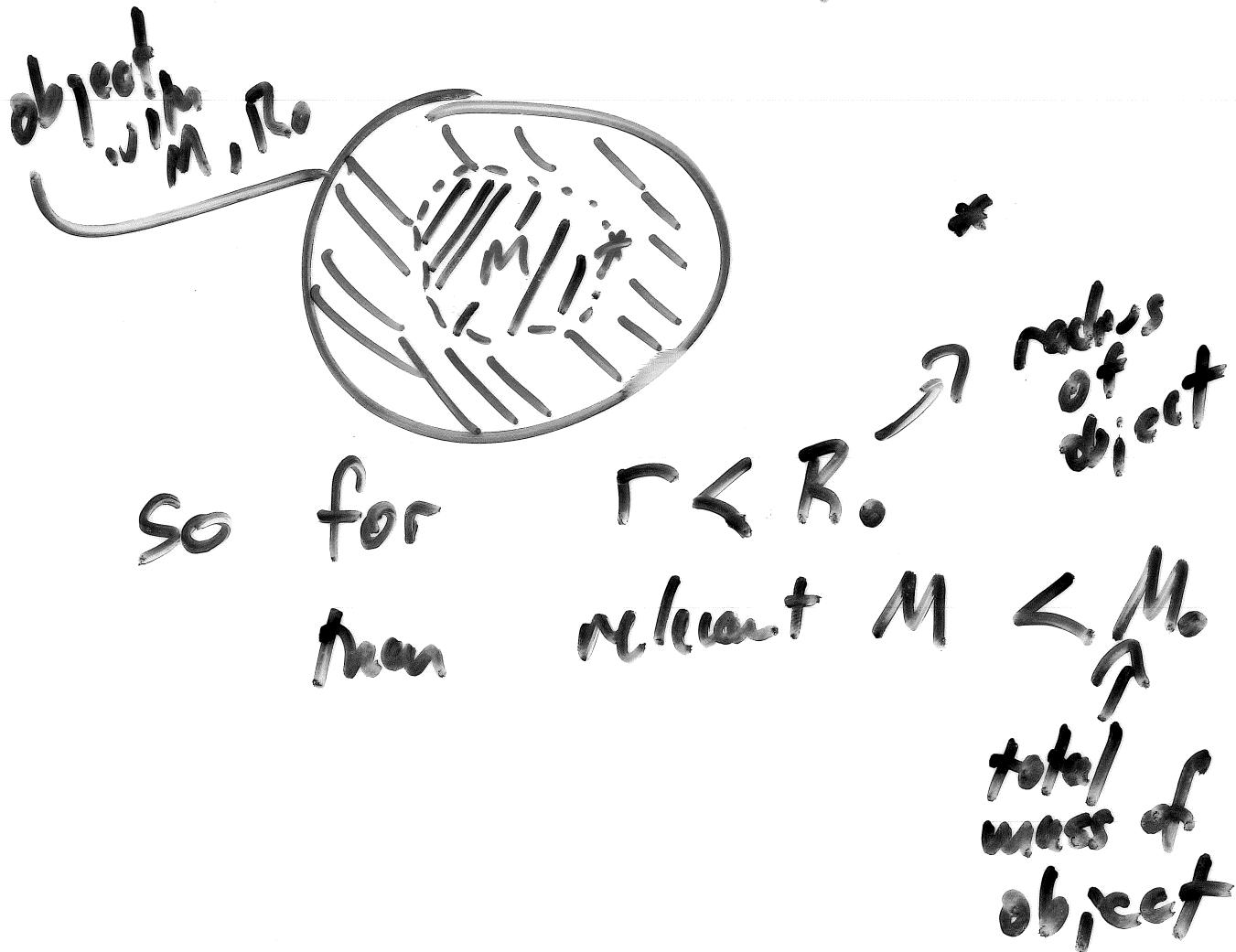
$\hookrightarrow$  some r where  
 $r = R_s$

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if  $R_o > R_s$

Then no  $r = R_s$

The relevant mass is  
mass INSIDE  $r$



so for  $r \leq R_s$

then relevant  $M \leq M_{\odot}$

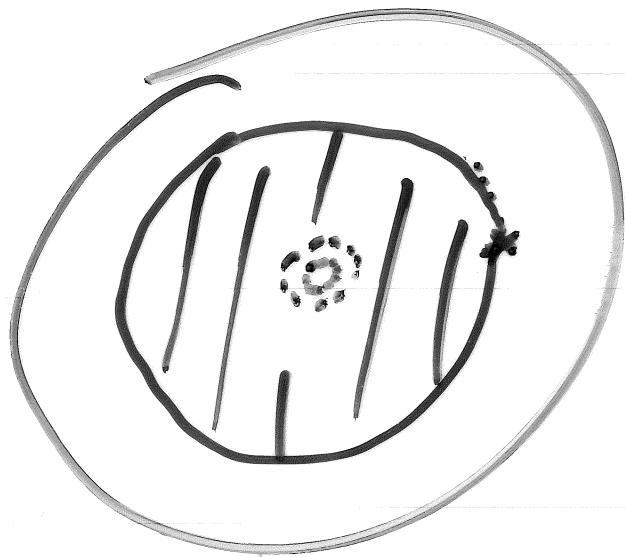
total mass of object

if  $R_s > R_0$

then there is no

$r \leq R_s$

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$$R_o > R_S$$

M

What's  $R_S$   
 That goes into the  
 metric for person X

$$R_o < R_S$$



$$r > R_S$$

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$r = R_S$  ARGH!

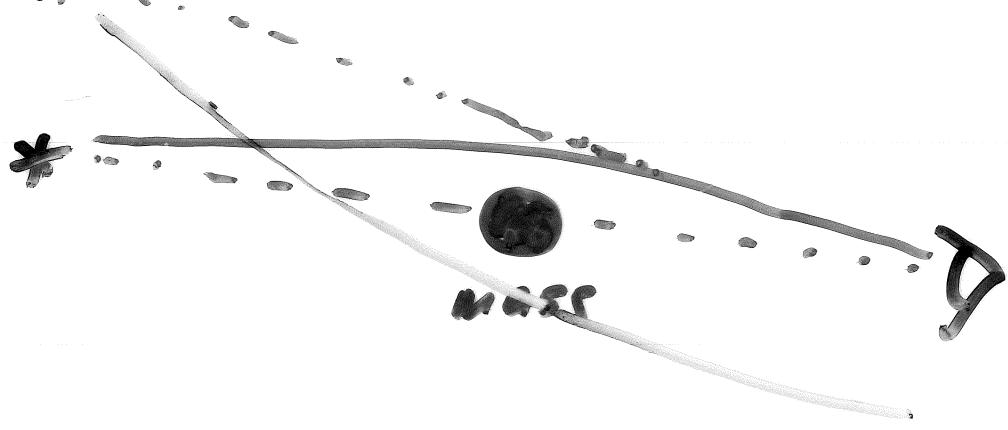
# POST-NEWTONIAN GRAVITATIONAL EFFECTS

P-N effect #1:

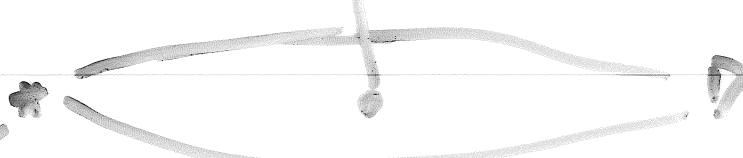
precession of perihelion  
(e.g. Mercury)

P-N effect #2:

\* deflection of light



galaxy

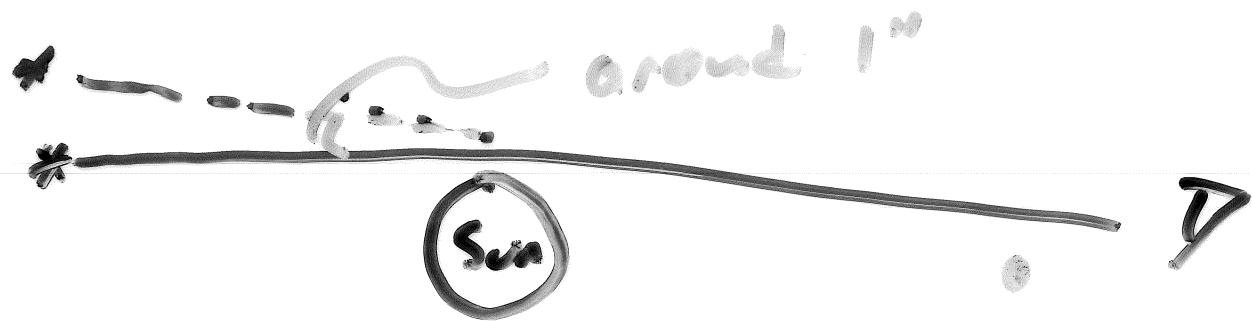


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*de Sitter, galaxy, quasar*

\* in solar system



Look at star behind sun  
appears to be in c  
different position than  
when observed at night.

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DO THIS BY OBSERVING  
DORING ECLIPSE

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1917 Einstein publishes G.R.

1919 eclipse in Brazil

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Eddington mounts  
expedition to Brazil  
WORKS

# FABLE: 1919 eclipse expedition

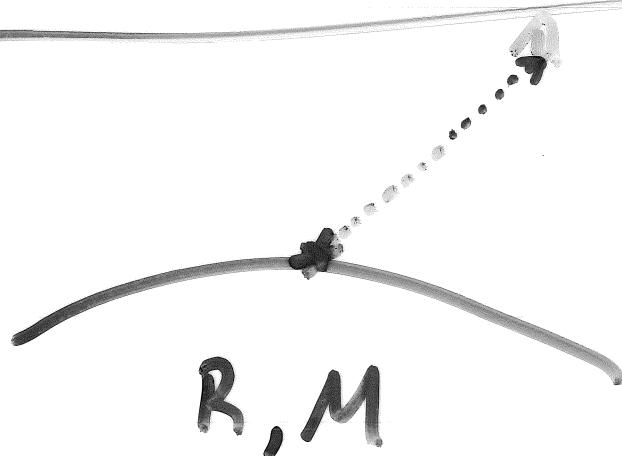
MORAL: Science is international  
universal quest

: Science works as  
advertised  
maybe?

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post- $N$  effect #3  
gravitational redshift

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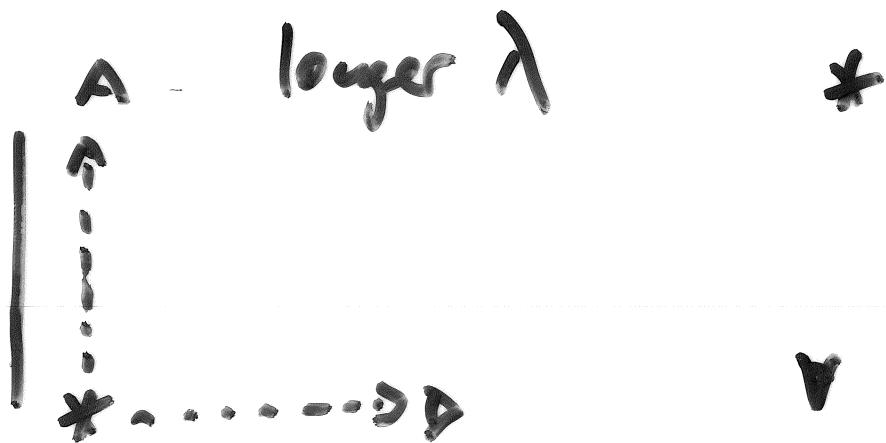
$$\frac{\Delta\lambda}{\lambda} = \frac{1}{1 - \frac{r_s}{R}} - 1$$

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distance to mass

$E$  of photon  
 =  $\frac{hc}{\lambda}$   $\rightarrow$  longer  
 gets less  
 Planck's constant

## TESTED IN LAS



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$$\frac{\Delta \lambda}{\lambda_0} = \frac{\Delta \lambda_{R1} - \Delta \lambda_{R2}}{\lambda_0}$$

P-N effect #4:

gravitational waves

as mass moves back & forth  
(in orbit)

→ ripples in space-time  
propagate outward at  
 $c$

The energy in "gravitational  
waves"

comes from orbit

orbite gets gradually  
smaller

objects spiral in

Can see this in binary  
stars with short orbit  
"BINARY PULSAR"

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