GRAVITATIONAL LENSING

LECTURE 2

Docente: Massimo Meneghetti

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CONTENTS

- Deflection in the strong field limit
- Lens equation
- Lensing potential

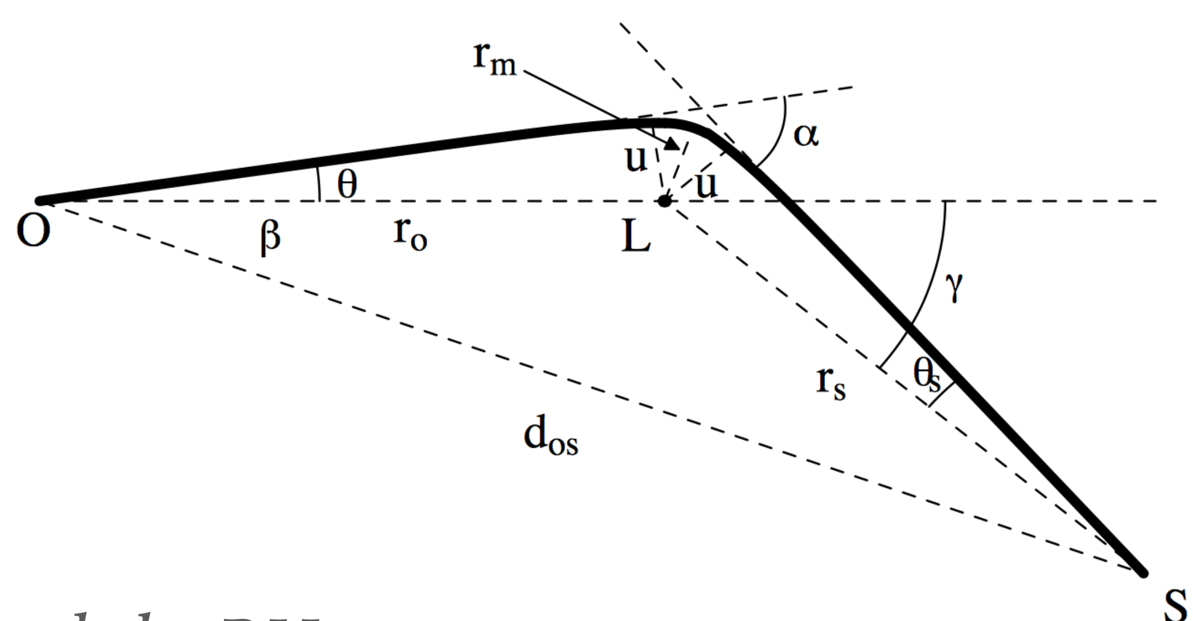
DEFLECTION OF LIGHT BY A BLACK HOLE

suggested reading: http://arxiv.org/pdf/0911.2187v2.pdf

Generic static spherically symmetric metric:

$$ds^2 = A(R)dt^2 - B(R)dR^2 - C(R)(d\theta^2 + \sin^2\theta d\phi^2)$$

$$\hat{\alpha} = -\pi + \frac{2G}{c^2}\int_{R_m}^{\infty} u\sqrt{\frac{B(R)}{C(R)[C(R)/A(R) - u^2]}}dR$$



u=impact parameter

R_m=minimum distance between the photon and the BH

$$u^2 = \frac{C(R_m)}{A(R_m)}$$

DEFLECTION OF LIGHT BY A BLACK HOLE

For the Schwarzschild metric:

$$A(R) = 1 - 2GM/Rc^2 \qquad B(R) = A(R)^{-1} \qquad C(R) = R^2$$

The weak-field limit holds for $R_m \gg 2GM/c^2$

The exact solution of the integral in the previous slide was found by Darwin (1959):

$$\hat{\alpha} = -\pi + 4\frac{G}{c^2}\sqrt{R_m/s}F(\varphi, m)$$

$$\begin{aligned} s &= \sqrt{(R_m - 2M)(R_m + 6M)} \\ m &= (s - R_m + 6M)/2s \\ \varphi &= \arcsin\sqrt{2s/(3R_m - 6M + s)} \end{aligned}$$

HOW DOES THE EXACT SOLUTION COMPARE TO THAT IN THE WFL?

?

See our first python exercise!