PHY-765 SS18: Gravitational Lensing. Worksheet Week 2

1 Select topic for poster presentation

A scientific poster is a key tool for presenting scientific studies, surveys, projects, topics, etc. The poster does so in a short, to-the-point and easily digestible format. It is often used at conferences as alternatives for talks, with dedicated poster sessions where conference attendees roam around the posters while chatting to the poster authors about the work presented. Hence, a poster is a great opportunity to interact with people at scientific conferences. In two weeks we will 'mock' a poster session, where each of you will present a poster to the rest of the group. But first we need some posters.

Poster presentations: **Wednesday May 3rd**

1.1

You will be presenting an already published paper in the form of a poster. Select a refereed paper among the most cited papers published between 1980 and 1995 that contain "gravitational lensing" in the abstract, i.e., (likely) high impact work with interesting results papers from the early days of GL. You probably want to avoid books and review articles, which are usually pretty long.

Please send your selected papers to me at before next Wednesday (April 25).

1.2

A scientific poster should summarize the paper. A good guideline for scientific posters is given by NYU at `https://guides.nyu.edu/posters`, but many other guidelines exist out there. Prepare the poster as PDF (use "print to PDF" if using Power-point/Keynote or similar) that you can present to the rest of us via the projector - *no need to actually print the poster!*.

1.3

Prepare a 3-5 minutes presentation of your poster. This will be followed by a few minutes for questions+answers about the poster afterwards.

2 Steps in deriving the Newtonian light deflection angle

This week we saw how Newtonian gravity can be used to make considerations about deflection of photons by point-masses. The following fleshes out some of the steps that were glossed over in this week's slides.

2.1

Using the second time derivative of a cylindrical vector field (where the z is 0, i.e. polar coordinates), convince yourself that representing $\frac{d^2\vec{r}}{dt^2}$ in this coordinate frame, results in the expression used on slide 6 of this week's slides.

2.2

Show that

$$\dot{R} = \frac{J_z R'}{R^2}$$

and

$$\ddot{R} = \frac{J_z^2}{R^2}\left[\frac{R''}{R^2} - 2\frac{R'^2}{R^3}\right]$$

which were inserted into the equation of motion on slide 7 of this week's slides.

2.3

Using that the equation of motion becomes

$$\frac{R''}{R^2} - 2\frac{R'^2}{R^3} - \frac{1}{R} = -\frac{MG}{J_z^2}$$

and that $u \equiv 1/R$, show that the equation of motion can be expressed as the inhomogeneous second order differential equation

$$u'' + u = -\frac{MG}{J_z^2}$$

3 Size of light deflection angles

In this final exercise we will get a feeling for the actual sizes of the deflection angles that we have derived

3.1

The deflection parameters α_{N} and α_{GR} can be expressed such that M and ξ are in units of $M_\odot$ and $R_\odot$, i.e.

$$\alpha = K\left(\frac{M}{M_\odot}\right)\left(\frac{\xi}{R_\odot}\right)^{-1}$$

with K being a constant. Determine K_{N} and K_{GR} in units of arc seconds.

3.2

What is α_{N} and α_{GR} for a point source behind the sun ($M = 1M_\odot$), and a massive black hole ($M = 10^6 M_\odot$) in the cases where the impact parameter is $10R_\odot$, $100R_\odot$ and $500R_\odot$?