PHY-765 SS19: Gravitational Lensing. Worksheet Week 13

1 Prepare Public Outreach

The last step in our 'astronomer skill development' ladder, is to take a look at public outreach. This is another important aspect of Astronomy and most other sciences. Public outreach is broadly defined as interaction and sharing topics and results from Astronomy with the public. Public outreach comes in many forms and flavors including: news paper or tv interviews and articles, press releases, scientific illustrations and videos, 'open house' days, public lectures and talks, school visits, hosting internships and institute visits, etc. Common for all of these are, that the scientific topic being presented, is presented to people who are members of the public with no detailed knowledge about physics and/or mathematics. Nevertheless, they share our interest and excitement about astronomy and physics. An involved, interested and supportive community is essential for the thriving of any institution performing fundamental research. This makes public outreach and important part of any scientists job - including astronomers.

1.1

Prepare a piece of scientific public outreach on the topic of gravitational lensing. It can be whatever you think an audience from the public find interesting. For example it could be a press-release of an exciting result from the literature, a crafty paper-mache/cardboard illustration for a school class, a public "science-slam" presentation, a short movie, an 'open house' poster, etc. The key point is that the outreach explains a concept of gravitational lensing at a level which can be understood by the public audience (of course there is a difference between public outreach in a 5th grade classroom, and at an open house day).

The presentation should be maximum 5 minutes long and will be given on **July 17th**.

2 The convergence in Fourier Space

The convergence in Fourier space, expressed in terms of the shear components, illustrates the Mass Sheet Degeneracy discussed in week 11.

2.1

Using that

$$(l_x + l_y)^2 = l_x^2 + l_y^2 + 2l_x l_y \tag{1}$$

and the definitions of $\tilde{\kappa}$, $\tilde{\gamma}_1$ and $\tilde{\gamma}_2$ given in this week's slides show that the convergence in Fourier space, can be expressed as

$$\tilde{\boldsymbol{\kappa}}(\boldsymbol{l}) = \frac{(l_x^2 - l_y^2)\tilde{\gamma}_1(\boldsymbol{l}) + 2l_x l_y \tilde{\gamma}_2(\boldsymbol{l})}{l^2} \tag{2}$$

which holds for all l, except $l = 0$ which corresponds to a constant (no variation) Fourier mode.

3 Defining the Power Spectrum from the Cross-Correlation

Using that in Fourier space

$$\int d^n x e^{-i\boldsymbol{x}\cdot\boldsymbol{l}} = (2\pi)^n \delta_{\text{Dirac}}(\boldsymbol{l}) \tag{3}$$

where n is the dimensionality of the integral, show that

$$\langle\tilde{\delta}(\boldsymbol{k})\tilde{\delta}(\boldsymbol{k'})\rangle = \int d^3x e^{-i\boldsymbol{k}\cdot\boldsymbol{x}} \int d^3y e^{-i\boldsymbol{k'}\cdot\boldsymbol{y}} \langle\delta(\boldsymbol{x})\delta(\boldsymbol{y})\rangle \tag{4}$$

leads to the definition of the Power Spectrum, $P(k)$ from this week's slides

$$P(|\boldsymbol{k}|) \equiv \int d^3x_- e^{i\boldsymbol{k}\cdot\boldsymbol{x}_-} \xi(\boldsymbol{x}_-) \tag{5}$$

for $\boldsymbol{x}_- = \boldsymbol{x} - \boldsymbol{y}$.