SIEP

a simple pseudo-elliptical lensing model

Generated by Doxygen 1.5.8

Tue Feb 15 22:57:13 2011

Contents

Chapter 1

Namespace Index

1.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

Chapter 2

File Index

2.1 File List

Here is a list of all documented files with brief descriptions:

Chapter 3

Namespace Documentation

3.1 siep_model Namespace Reference

3.1.1 Detailed Description

Package to compute the main lensing functions, critical curves, caustics and constant distortion curves for the SIEP (Singular Isothermal Elliptical Potential) model

See Chap.4 in ...sltools/PerturbativeMethod/writeups/Report_on_Perturbative_Method.pdf

Notice: This model have 3 main parameters.

siep_params[0]: Integer useful to choose the parameterization for the ellipticity

If siep_params[0]=1, It uses the Angle Deflection Model, i.e., $a_{1\varepsilon} = 1 - \varepsilon$ and $a_{2\varepsilon} = 1 + \varepsilon$

If siep_params[0]=2, It uses the Keeton´s parametrization, i.e., $a_{1\varepsilon} = 1$ and $a_{2\varepsilon} = (1 - \varepsilon)^{-2}$

siep_params[1]: Ellipticity value (must be ellipticity parameter or the ellipticity by itself whether the angle deflection is used)

siep_params[2]: Mass of the SIS model, related wit the velocity dispersion.

Chapter 4

File Documentation

4.1 siep_curves.h File Reference

```
#include <math.h>
#include <cstdlib>
#include "siep_lens_funct.h"
```

Namespaces

- namespace siep_model

Defines

- #define **PI** 3.14159265358979323846264338327950
- #define **TAM_MAX** 2000

Functions

- double r_cct_siep (double theta, double siep_params[ ])
- double r_th_siep (double theta, double siep_params[ ], double rth)
- double r_ccr_siep (double theta, double siep_params[ ])
- void cc_tan_siep (double siep_params[ ], double xtcc[ ], double ytcc[ ], int npts=1000, FILE ∗file_in1=NULL)
- void cc_lw_pos_siep (double siep_params[ ], double lw_th, double xlwp[ ], double ylwp[ ], int npts=1000, FILE ∗file_in1=NULL)
- void cc_lw_neg_siep (double siep_params[ ], double lw_th, double xlwn[ ], double ylwn[ ], int npts=1000, FILE ∗file_in1=NULL)
- void cc_rad_siep (double siep_params[ ], double xrad[ ], double yrad[ ], int npts=1000, FILE ∗file_in1=NULL)
- double **cross_section_siep** (double siep_params[ ], double lw_ratio, int npts=1000)

4.1.1 Detailed Description

In this file, we find the functions that are useful to compute:

Tangential and Radial Critical Curves

Tangential and Radial Caustics

Curves of constant distortion in both planes.

Cross section for deformation arcs (... in progress)

4.1.2 Function Documentation

4.1.2.1 void cc_lw_neg_siep (double *siep_params*[ ], double *lw_th*, double *xlwn*[ ], double *ylwn*[ ], int *npts* = `1000`, FILE ∗ *file_in1* = `NULL`)

A functions to print the constant distortion curve for $R_{\rm th} < 0$ for the SIEP

In the lens plane this function plot the following parametric equation:

$$x_{1,lwn} = \frac{x_{\varepsilon,R_{\rm th}} \cos\phi_\varepsilon}{\sqrt{a_{1\varepsilon}}}$$

$$x_{2,lwn} = \frac{x_{\varepsilon,R_{\rm th}} \sin\phi_\varepsilon}{\sqrt{a_{2\varepsilon}}}$$

In the source plane, this function plot the following parametric equation:

$$y_{1,lwn} = x_{1,lwn} - \sqrt{a_{1\varepsilon}} \cos\phi_\varepsilon$$

$$y_{2,lwn} = x_{2,lwn} - \sqrt{a_{2\varepsilon}} \sin\phi_\varepsilon$$

Parameters:

siep_params[ ] : SIEP parameters

xlwn[ ] : Vector containing the first coordinate of the constant distortion curve in the lens plane for $R_{\rm th} < 0$

ylwn[ ] : Vector containing the second coordinate of the constant distortion curve in the lens plane for $R_{\rm th} < 0$

npts : number of point to divide the range in values of theta, by default=1000

Returns:

by default the vector (xlwn,ylwn) or if it is indicated a data file containing such vector

See also:

r_th_siep

4.1.2.2 void cc_lw_pos_siep (double *siep_params*[ ], double *lw_th*, double *xlwp*[ ], double *ylwp*[ ], int *npts* = `1000`, FILE ∗ *file_in1* = `NULL`)

A functions to print the constant distortion curve for $R_{\rm th} > 0$ for the SIEP

In the lens plane this function plot the following parametric equation:

$$x_{1,lwp} = \frac{x_{\varepsilon,R_{\rm th}} \cos\phi_\varepsilon}{\sqrt{a_{1\varepsilon}}}$$

$x_{2,lwp} = \frac{x_{\varepsilon,R_{\rm th}} \sin\phi_\varepsilon}{\sqrt{a_{2\varepsilon}}}$

In the source plane, this function plot the following parametric equation:

$y_{1,lwp} = x_{1,lwp} - \sqrt{a_{1\varepsilon}} \cos\phi_\varepsilon$

$y_{2,lwp} = x_{2,lwp} - \sqrt{a_{2\varepsilon}} \sin\phi_\varepsilon$

Parameters:

siep_params[ ] : SIEP parameters

xlwp[ ] : Vector containing the first coordinate of the constant distortion curve in the lens plane for $R_{\rm th} > 0$

ylwp[ ] : Vector containing the second coordinate of the constant distortion curve in the lens plane for $R_{\rm th} > 0$

npts : number of point to divide the range in values of theta, by default=1000

Returns:

by default the vector (xlwp,ylwp) or if it is indicated a data file containing such vector

See also:

r_th_siep

4.1.2.3 void cc_rad_siep (double *siep_params*[ ], double *xrad*[ ], double *yrad*[ ], int *npts* = `1000`, FILE ∗ *file_in1* = `NULL`)

A functions to print the radial curves (critical and caustic) for the SIEP

For the radial critical curve, this function plot the following parametric equation:

$x_{1,rcc} = 0$

$x_{2,rcc} = 0$

For the radial caustic, this function plot the following parametric equation:

$y_{1,rca} = -\sqrt{a_{1\varepsilon}} \cos\phi_\varepsilon$

$y_{2,rca} = -\sqrt{a_{2\varepsilon}} \sin\phi_\varepsilon$

Parameters:

siep_params[ ] : SIEP parameters

xrad[ ] : Vector containing the first coordinate of the radial critical curve

yrad[ ] : Vector containing the second coordinate of the radial critical curve

npts : number of point to divide the range in values of theta, by default=1000

Returns:

by default the vector (xrad,yrad) or if it is indicated a data file containing such vector

See also:

r_ccr_siep

4.1.2.4 void cc_tan_siep (double *siep_params*[ ], double *xtcc*[ ], double *ytcc*[ ], int *npts* = 1000, FILE ∗ *file_in1* = NULL)

A functions to print the tangential curves (critical and caustic) for the SIEP

For the tangential critical curve, this function plot the following parametric equation:

$$x_{1,tcc} = \frac{x_{\varepsilon,tcc}\cos\phi_\varepsilon}{\sqrt{a_{1\varepsilon}}}$$

$$x_{2,tcc} = \frac{x_{\varepsilon,tcc}\sin\phi_\varepsilon}{\sqrt{a_{2\varepsilon}}}$$

For the tangential caustic, this function plot the following parametric equation:

$$y_{1,tca} = x_{1,tcc} - \sqrt{a_{1\varepsilon}}\cos\phi_\varepsilon$$

$$y_{2,tca} = x_{2,tcc} - \sqrt{a_{2\varepsilon}}\sin\phi_\varepsilon$$

Parameters:

siep_params[ ] : SIEP parameters
xtcc[ ] : Vector containing the first coordinate of the tangential critical curve
ytcc[ ] : Vector containing the second coordinate of the tangential critical curve
npts : number of point to divide the range in values of theta, by default=1000

Returns:

by default the vector (xtcc,ytcc) or if it is indicated a data file containing such vector

See also:

r_cct_siep

4.1.2.5 double r_ccr_siep (double *theta*, double *siep_params*[ ])

Radial Coordinate of the Radial Critical Curve

$x_{\varepsilon,rcc} = 0,$

Returns:

$x_{\varepsilon,rcc}(x)$

4.1.2.6 double r_cct_siep (double *theta*, double *siep_params*[ ])

Pseudo-Elliptical Radial Coordinate of the Tangential Critical Curve of the SIEP model

$x_{\varepsilon,tcc} = \mathcal{A}(\varepsilon) - \mathcal{B}(\varepsilon)\cos 2\phi_\varepsilon$, where $\mathcal{A}(\varepsilon)$ and $\mathcal{B}(\varepsilon)$ are already defined in siep_lens_funct.h

Parameters:

theta : angular coordinate, and therefore $\phi_\varepsilon = \arctan\left(\sqrt{\frac{a_{2\varepsilon}}{a_{1\varepsilon}}}\tan(\theta)\right)$
siep_params[ ] : parameters of the SIEP model

Returns:

$x_{\varepsilon,tcc}(x)$

4.1.2.7 double r_th_siep (double *theta*, double *siep_params*[ ], double *rth*)

Pseudo-Elliptical Radial Coordinate of the Constant Distortion curve.

$$x_{\varepsilon,R_{\rm th}} = x_{\varepsilon,tcc} \times \begin{cases} \dfrac{|R_{\rm th}|}{|R_{\rm th}|-1}, & R_{\rm th}>0 \\ \dfrac{|R_{\rm th}|}{|R_{\rm th}|+1}, & R_{\rm th}<0 \end{cases},$$

Returns:

$x_{\varepsilon,R_{\rm th}}(x)$

See also:

r_cct_siep

4.2 siep_inver_lens.h File Reference

4.2.1 Detailed Description

In this file, we find the inverse solution for lensing due SIEP model, and it allow us

Plot images of lensed sources

Knowing the data point, obtain the lens parameters.

status(... as soon is possible)

4.3 siep_lens_funct.h File Reference

```
#include <math.h>
#include <cstdlib>
```

Functions

- double alpha_sis (double siep_params[ ])
- double kappa_sis (double r, double siep_params[ ])
- double gamma_sis (double r, double siep_params[ ])
- double kappa_siep (double xi1, double xi2, double siep_params[ ])
- double gamma1_siep (double xi1, double xi2, double siep_params[ ])
- double gamma2_siep (double xi1, double xi2, double siep_params[ ])
- double gamma_siep (double xi1, double xi2, double siep_params[ ])
- double alpha1_siep (double xi1, double xi2, double siep_params[ ])
- double alpha2_siep (double xi1, double xi2, double siep_params[ ])
- double y1_siep (double xi1, double xi2, double siep_params[ ])
- double y2_siep (double xi1, double xi2, double siep_params[ ])

4.3.1 Detailed Description

This module is useful to compute quantities related to the Singular Isothermal Elliptical Potential (SIEP)

See sltools/PerturbativeMethod/writeups/Report_on_Perturbative_Method.pdf

Lensing functions to be considered: angle deflection, convergence, components of the shear.

Lens Equation

Notice: This model have 3 main parameters.

siep_params[0]: Integer useful to choose the flag for the parameterization for the ellipticity

If siep_params[0]=1, It uses $a_{1\varepsilon} = 1 - \varepsilon$ and $a_{2\varepsilon} = 1 + \varepsilon$

If siep_params[0]=2, It uses $a_{1\varepsilon} = 1$ and $a_{2\varepsilon} = (1 - \varepsilon)^{-2}$

siep_params[1]: Ellipticity value (must be ellipticity parameter or ellipticity by itself whether the angle deflection model is used)

siep_params[2]: Mass of the SIS model, related wit the velocity dispersion.

4.3.2 Function Documentation

4.3.2.1 double alpha1_siep (double *xi1*, double *xi2*, double *siep_params*[ ])

First component of the deflection angle of the SIEP model

$\alpha_{1\varepsilon} = \alpha(x_\varepsilon)\sqrt{a_{1\varepsilon}}\cos\phi_\varepsilon$

where $\phi_\varepsilon = \arctan\left(\frac{\sqrt{a_{2\varepsilon}}x_2}{\sqrt{a_{1\varepsilon}}x_1}\right)$

Parameters:

xi1,xi2 : are the cartesian coordinates

siep_params[ ] : SIEP parameters

Returns:

$\alpha_{1,\varepsilon}(x)$

4.3.2.2 double alpha2_siep (double *xi1*, double *xi2*, double *siep_params*[ ])

Second component of the deflection angle of the SIEP model

$\alpha_{2\varepsilon} = \alpha(x_\varepsilon)\sqrt{a_{2\varepsilon}}\sin\phi_\varepsilon$

where $\phi_\varepsilon = \arctan\left(\frac{\sqrt{a_{2\varepsilon}}x_2}{\sqrt{a_{1\varepsilon}}x_1}\right)$

Parameters:

xi1,xi2 : are the cartesian coordinates

siep_params[ ] : SIEP parameters

Returns:

$\alpha_{2,\varepsilon}(x)$

4.3.2.3 double alpha_sis (double *siep_params*[ ])

Module of the Angle deflection of the SIS model.

$\alpha(r) = 1,$

Returns:

$\alpha(r)$

4.3.2.4 double gamma1_siep (double *xi1*, double *xi2*, double *siep_params*[ ])

First component of the shear of the SIEP model

$\gamma_{1\varepsilon}(\vec{x}) = \mathcal{B}(\varepsilon)\kappa(x_\varepsilon) - \mathcal{A}(\varepsilon)\gamma(x_\varepsilon)\cos 2\phi_\varepsilon$

where $\mathcal{A}(\varepsilon) = \frac{1}{2}(a_{1\varepsilon} + a_{2\varepsilon})$, $\mathcal{B}(\varepsilon) = \frac{1}{2}(a_{1\varepsilon} - a_{2\varepsilon})$ and $\phi_\varepsilon = \arctan\left(\frac{\sqrt{a_{2\varepsilon}}x_2}{\sqrt{a_{1\varepsilon}}x_1}\right)$

Parameters:

xi1,xi2,: cartesian coordinates

siep_params[ ] : SIEP parameters

Returns:

$\gamma_{1\varepsilon(x)}$

4.3.2.5 double gamma2_siep (double *xi1*, double *xi2*, double *siep_params*[ ])

Second component of the shear of the SIEP model (see report)

$\gamma_{2\varepsilon}(\vec{x}) = -\sqrt{\mathcal{A}^2(\varepsilon) - \mathcal{B}^2(\varepsilon)}\gamma(x_\varepsilon)\sin 2\phi_\varepsilon$

where $\mathcal{A}(\varepsilon) = \frac{1}{2}(a_{1\varepsilon} + a_{2\varepsilon})$, $\mathcal{B}(\varepsilon) = \frac{1}{2}(a_{1\varepsilon} - a_{2\varepsilon})$ and $\phi_\varepsilon = \arctan\left(\frac{\sqrt{a_{2\varepsilon}}x_2}{\sqrt{a_{1\varepsilon}}x_1}\right)$

Parameters:

xi1,xi2 : cartesian coordinates

siep_params[ ] : SIEP parameters

Returns:

$\gamma_{2\varepsilon(x)}$

4.3.2.6 double gamma_siep (double *xi1*, double *xi2*, double *siep_params*[ ])

Shear (modulus) of the SIEP model

$\gamma_\varepsilon(\vec{x}) = \mathcal{A}(\varepsilon)\kappa(x_\varepsilon) - \mathcal{B}(\varepsilon)\gamma(x_\varepsilon)\cos 2\phi_\varepsilon$

where $\mathcal{A}(\varepsilon) = \frac{1}{2}(a_{1\varepsilon} + a_{2\varepsilon})$, $\mathcal{B}(\varepsilon) = \frac{1}{2}(a_{1\varepsilon} - a_{2\varepsilon})$ and $\phi_\varepsilon = \arctan\left(\frac{\sqrt{a_{2\varepsilon}}x_2}{\sqrt{a_{1\varepsilon}}x_1}\right)$

Parameters:

xi1,xi2 : are the cartesian coordinates

siep_params[ ] : SIEP parameters

Returns:

$\gamma_\varepsilon(x)$

4.3.2.7 double gamma_sis (double *r*, double *siep_params*[ ])

Shear of the SIS model.

$\gamma(r) = \frac{1}{2x}$,

$x = b/r$, where b is the parameter characterizing the mass of the SIS, related with the velocity dispersion

Parameters:

r : radial distance,

b : SIS lens parameters,

Returns:

$\kappa(r)$

4.3.2.8 double kappa_siep (double *xi1*, double *xi2*, double *siep_params*[ ])

Convergence of the SIEP model

$\kappa_\varepsilon(\vec{x}) = \mathcal{A}(\varepsilon)\kappa(x_\varepsilon) - \mathcal{B}(\varepsilon)\gamma(x_\varepsilon)\cos 2\phi_\varepsilon$

where $\mathcal{A}(\varepsilon) = \frac{1}{2}(a_{1\varepsilon} + a_{2\varepsilon})$, $\mathcal{B}(\varepsilon) = \frac{1}{2}(a_{1\varepsilon} - a_{2\varepsilon})$ and $\phi_\varepsilon = \arctan\left(\frac{\sqrt{a_{2\varepsilon}}x_2}{\sqrt{a_{1\varepsilon}}x_1}\right)$

Parameters:

xi1,xi2 : are the cartesian coordinates

siep_params[ ] : SIEP parameters

Returns:

$\kappa_\varepsilon(x)$

4.3.2.9 double kappa_sis (double *r*, double *siep_params*[ ])

Convergence of the SIS model.

$\kappa(r) = \frac{1}{2x}$,

$x = b/r$, where b is the parameter characterizing the mass of the SIS, related with the velocity dispersion

Parameters:

r : radial distance,

b : SIS lens parameters,

Returns:

$\kappa(r)$

4.3.2.10 double y1_siep (double *xi1*, double *xi2*, double *siep_params*[ ])

First component of the lens equation for the SIEP model

$y_1(x) = \frac{x_\varepsilon \cos\phi_\varepsilon}{\sqrt{a_{1\varepsilon}}} - \sqrt{a_{1\varepsilon}}\cos\phi_\varepsilon$

where $\phi_\varepsilon = \arctan\left(\frac{\sqrt{a_{2\varepsilon}}x_2}{\sqrt{a_{1\varepsilon}}x_1}\right)$

Parameters:

xi1,xi2 : are the cartesian coordinates

siep_params[ ] : SIEP parameters

Returns:

$y_1(x)$

4.3.2.11 double y2_siep (double *xi1*, double *xi2*, double *siep_params*[ ])

Second component of the lens equation for the SIEP model

$y_2(x) = \frac{x_\varepsilon \sin\phi_\varepsilon}{\sqrt{a_{2\varepsilon}}} - \sqrt{a_{2\varepsilon}} \sin\phi_\varepsilon$

where $\phi_\varepsilon = \arctan\left(\frac{\sqrt{a_{2\varepsilon}} x_2}{\sqrt{a_{1\varepsilon}} x_1}\right)$

Parameters:

xi1,xi2 : are the cartesian coordinates

siep_params[ ] : SIEP parameters

Returns:

$y_2(x)$