Pipeline III, Galaxy decompositions: BDBAR

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TOPICS:

1) BDBAR: what it does, some decomposition examples

2) Decomposition strategy in general

3) NIRQO - force profiles $\Rightarrow$ part of pipeline?

BDBAR

Originally *BULGE-DISK-BAR* $\Rightarrow$ *now includes up to 3 bar/oval components, ring-component*

Written in IDL, output via fits and IDL sav-files. Minimization with CURVEFIT (gradient-expansion method)

- ***GENERALIZED ELLIPTICAL ISOPHOTES:*** $r = (|x|^{c+2} + |y/q|^{c+2})^{1/(c+2)}$,
  shape-parameter c***, axial ratio*** q***, position angle*** ϕ

- ***MODEL-COMPONENTS***

  EXPONENTIAL DISK: $I_d(r) = I_d(0)\exp[-(r/h_R)]$

  SERSIC's FUNCTION (bulge, bar, ovals): $I_b(r) = I_b(0)\exp[-(r/h_b)^{\beta}]$

  FERRERS FUNCTION (bar, ovals): $I_{bar}(r) = I_{bar}(0)\ (1-(r/a_{bar})^2)^{n_{bar}+0.5}$

  GAUSSIAN RING: $I_r(r) = I_r(a_r)\exp[-\frac{1}{2}\left(\frac{r-a_r}{W_r}\right)^2]$

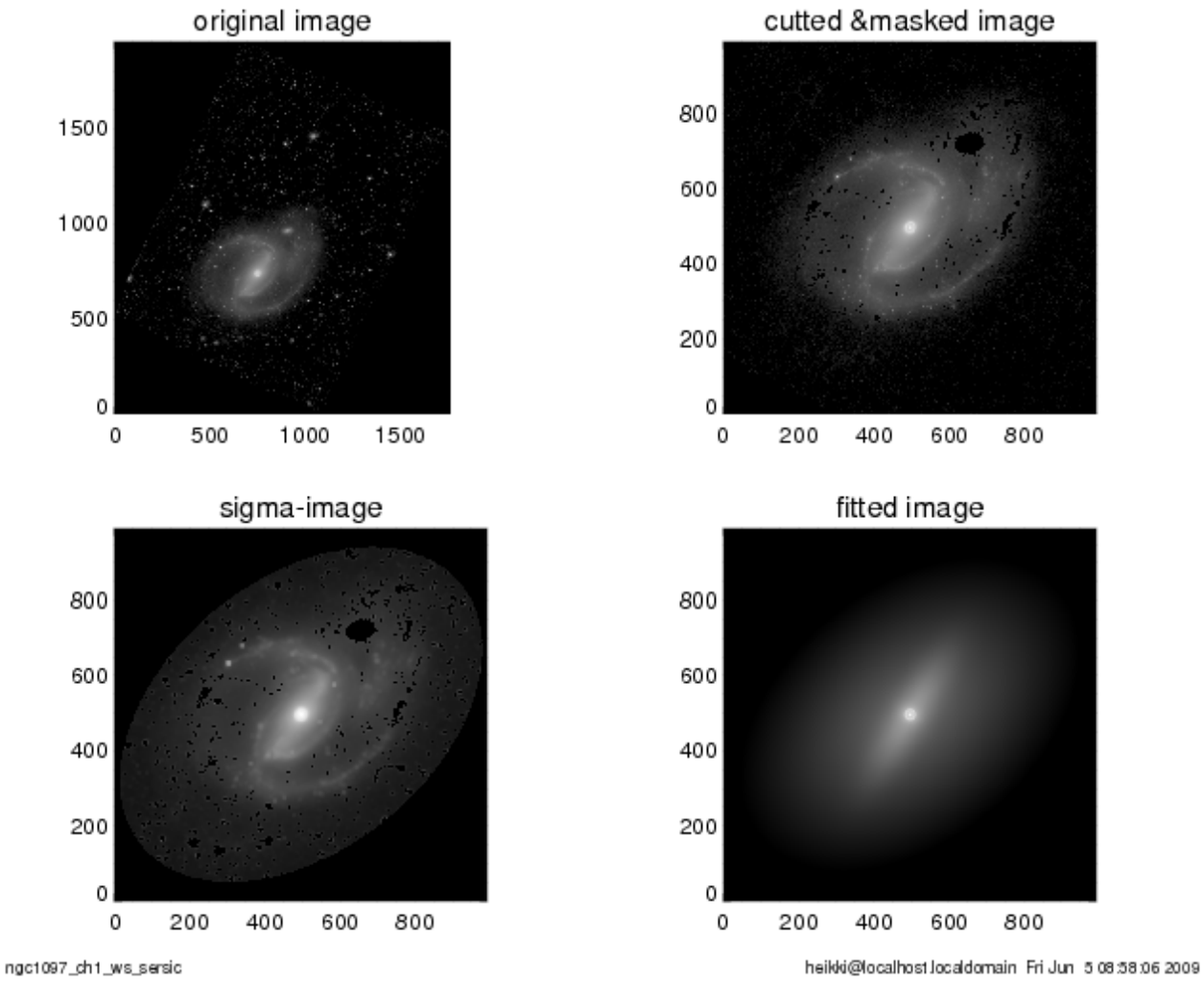
  CENTRAL POINT SOURCE $I_n(0)$ ***SKY BACKGROUND*** I_{sky}

- **SEVERAL WEIGHT-OPTIONS (including σ-map)**

- **BAD PIXEL MASK**

- **CONVOLUTION WITH PSF AT THE DESIRED REGION AROUND CENTER**

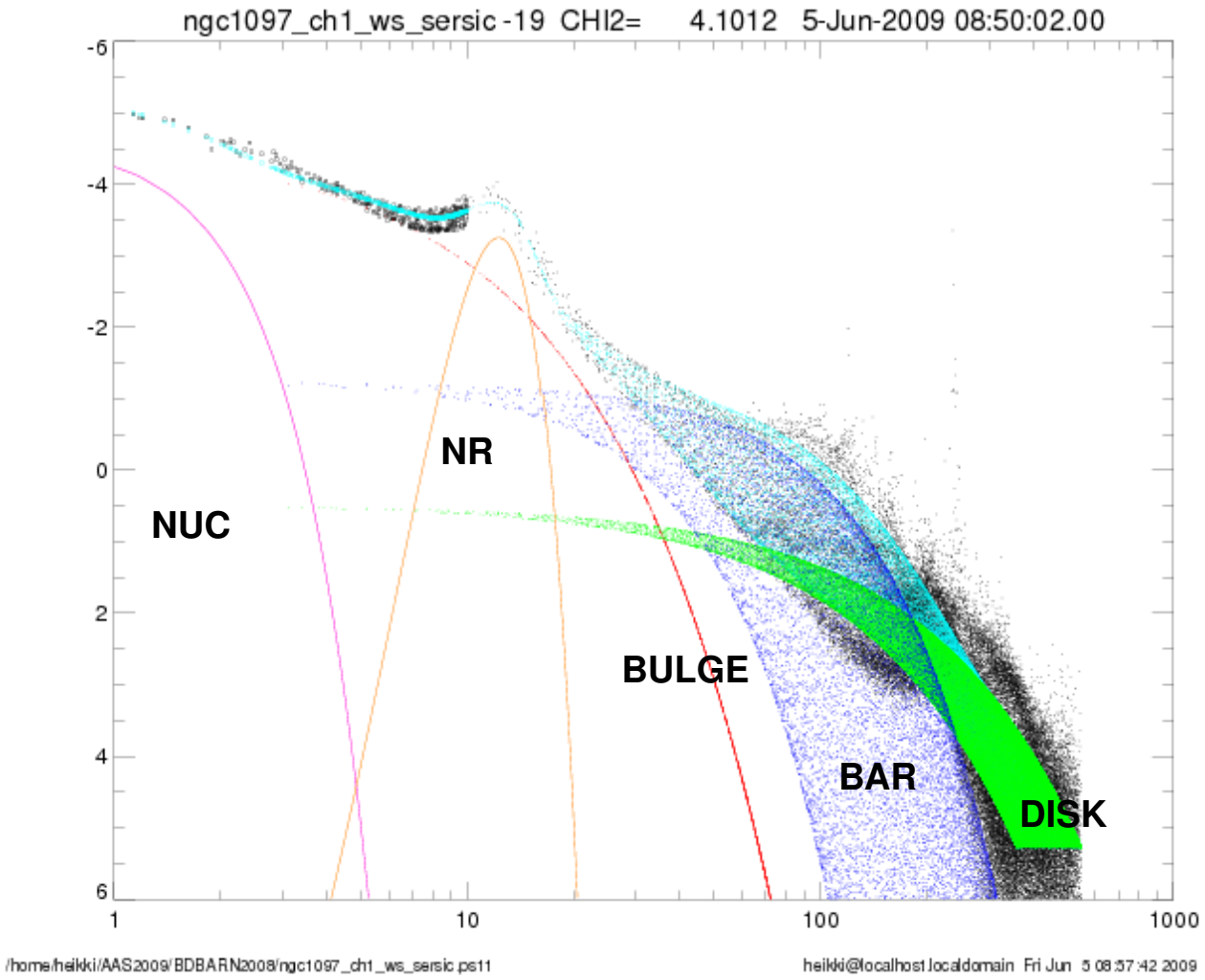
EXAMPLE: 5-COMPONENT BDBAR FIT FOR NGC1097 (1)



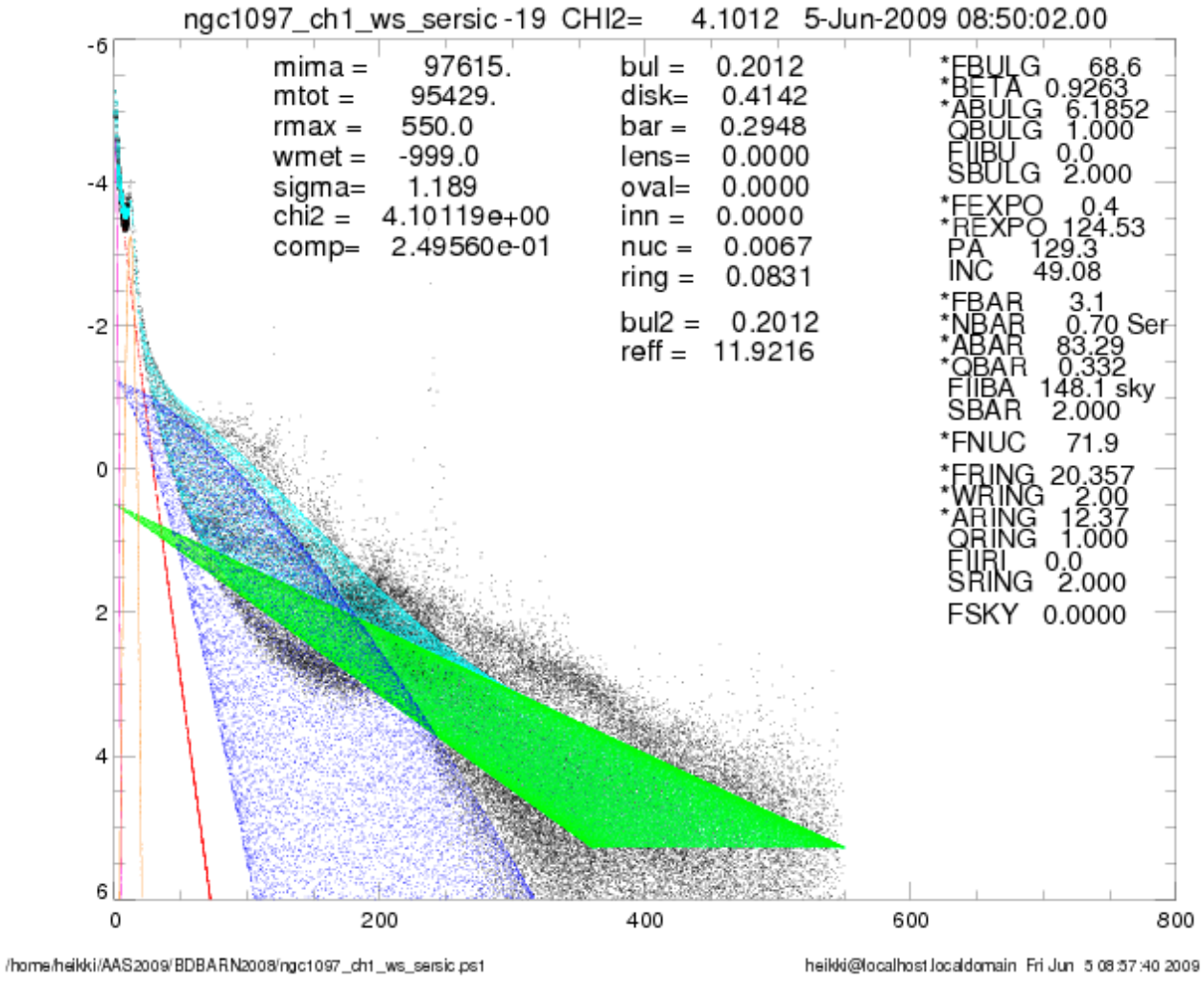
Model: Bulge + Disk + Bar + Nucleus + Nuclear ring

Joannah's mask

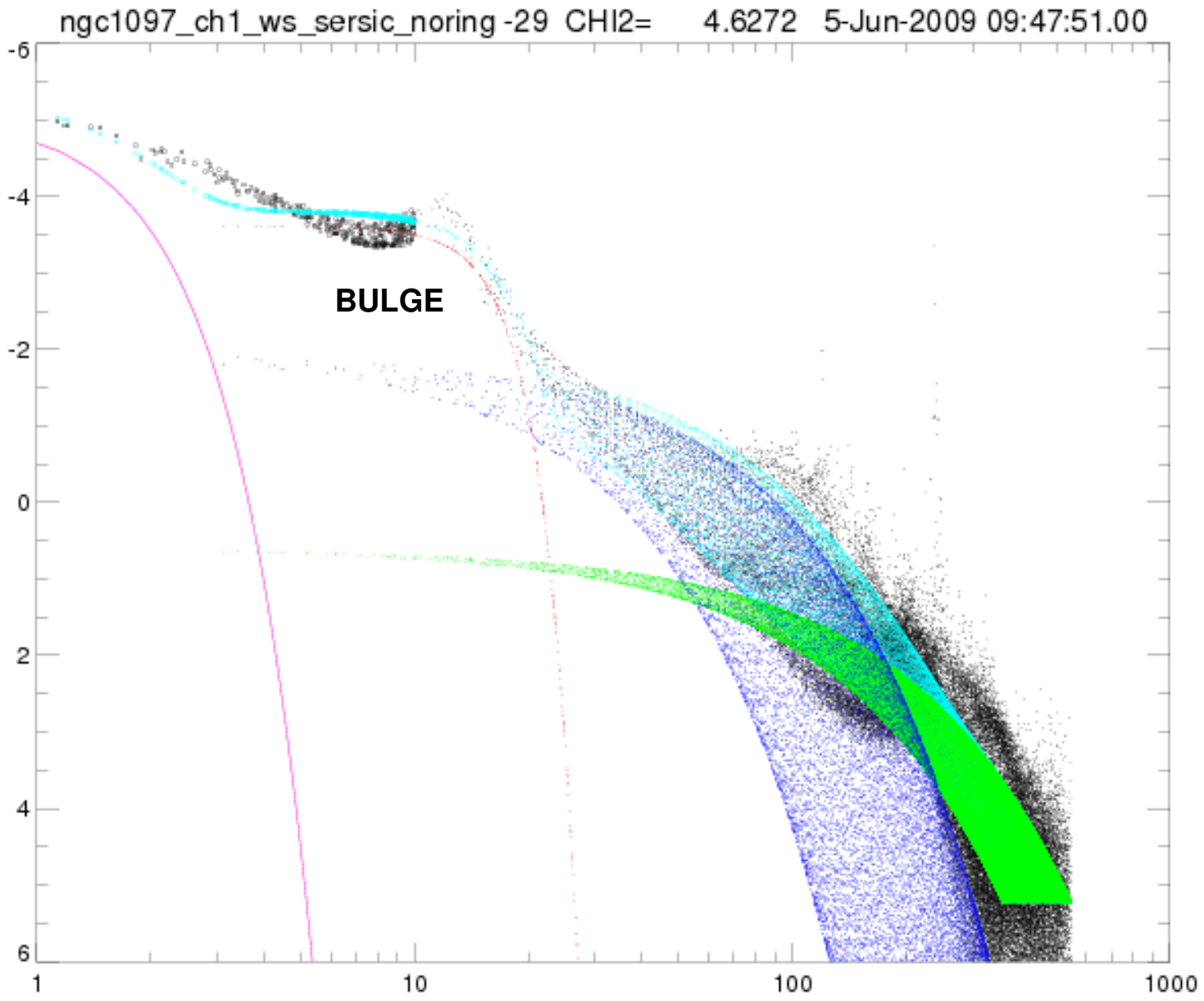
5-COMPONENT BDBAR FIT FOR NGC1097 (2)



5-COMPONENT BDBAR FIT FOR NGC1097 (3)

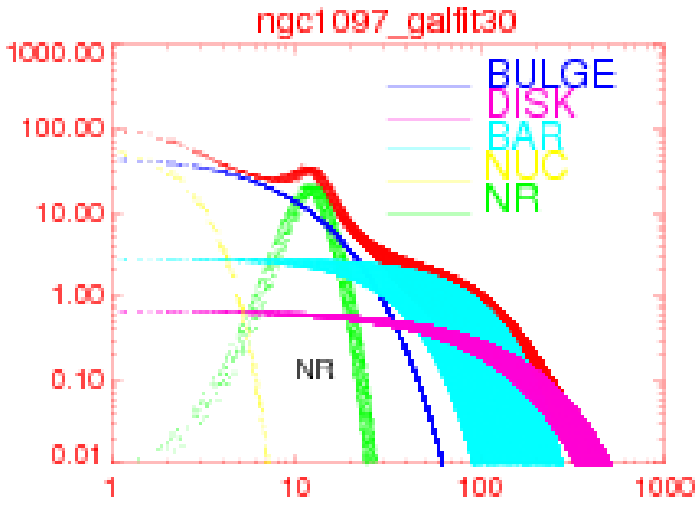


NUCLEAR RING OMITTED FROM NGC1097 MODEL

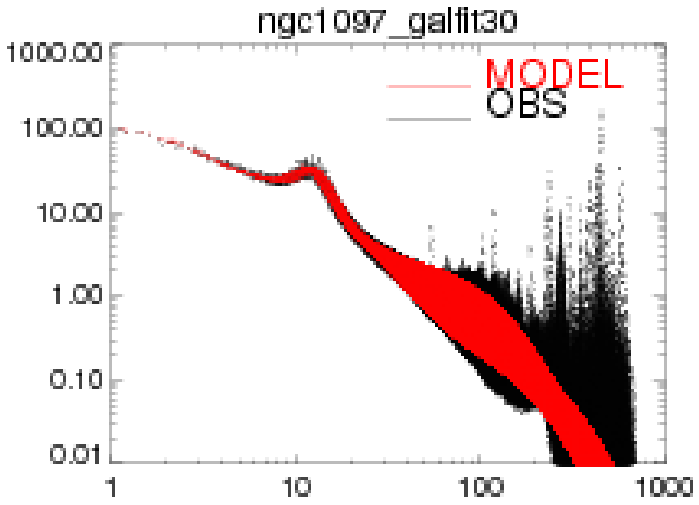


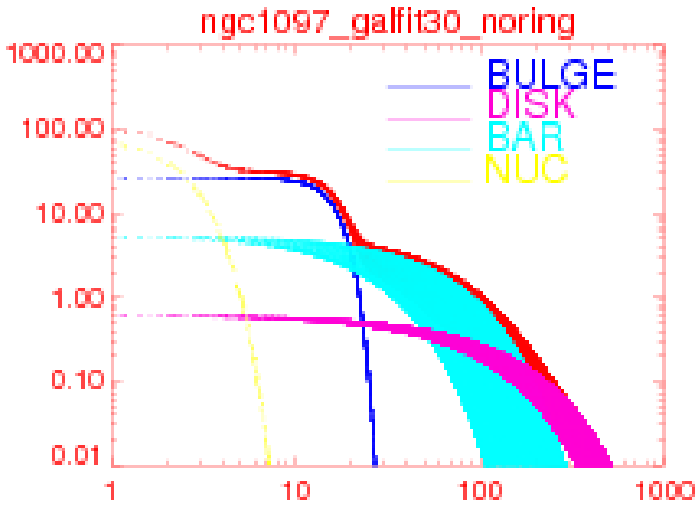
SAME MODELS RUN WITH GALFIT3.0

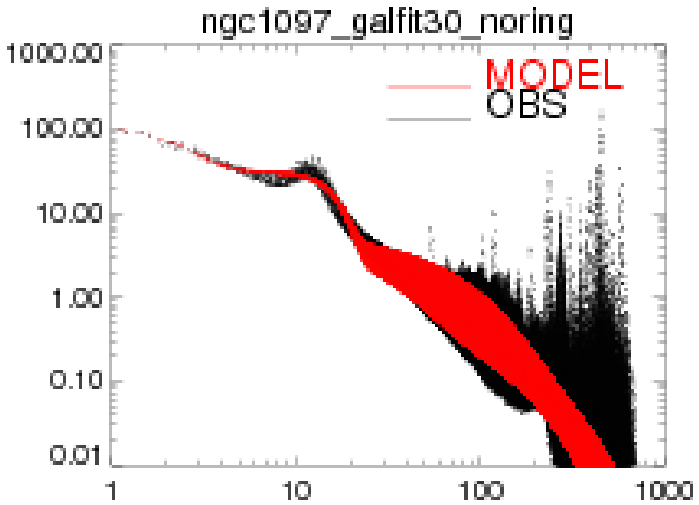
Model components



Obs + total model







RELIABILITY OF NGC 1097 FIT PARAMS?:

5-component fit with Sersic or Ferrers bar $\Rightarrow$ practically same results

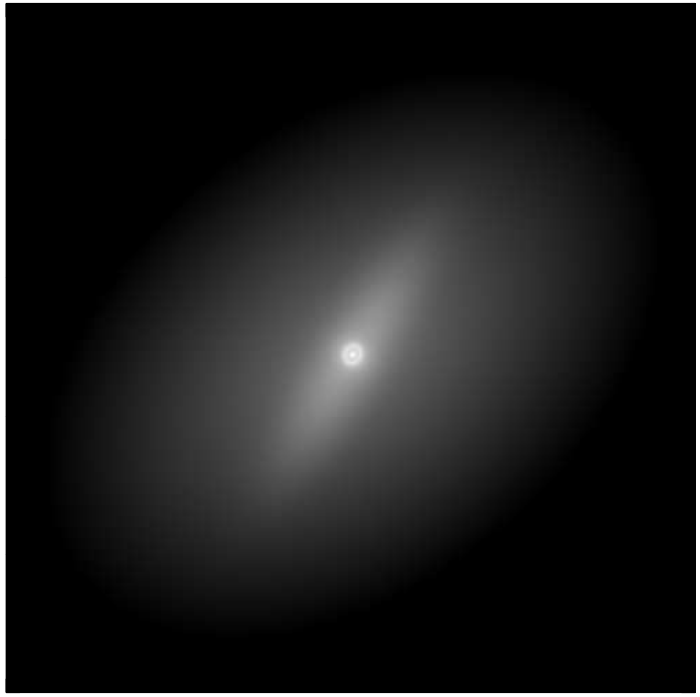
Numbers in parenthesis obtained with GALFIT3.0 $\Rightarrow$ good agreement with BDBAR

Both codes: omitting the nuclear ring $\Rightarrow$ very different fitted bulge!

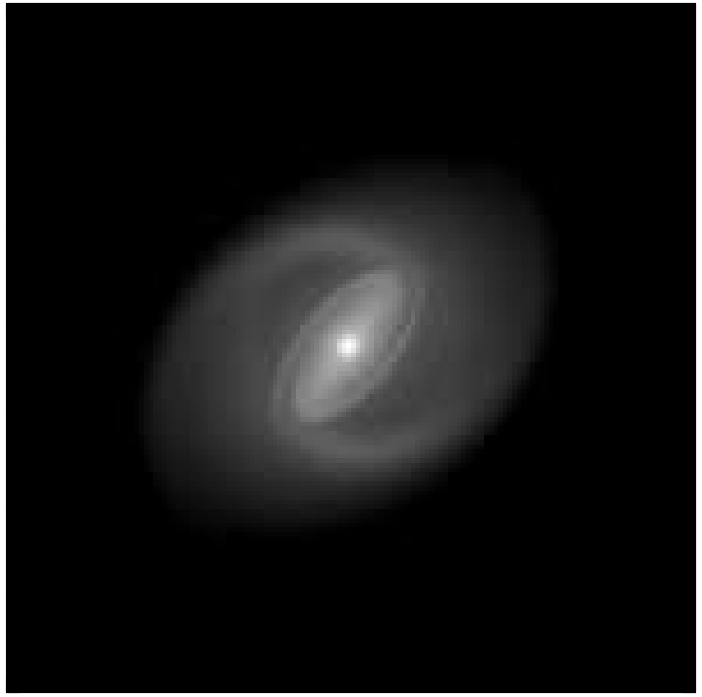
	Ferrers bar	Sersic Bar	Sersic Bar & no nuclear ring
Bulg/T	0.215	0.201 (0.187)	0.226 (0.220)
Disk/T	0.435	0.414 (0.417)	0.396 (0.400)
Bar /T	0.260	0.295 (0.288)	0.367 (0.361)
Nucl/T	0.007	0.007 (0.012)	0.010 (0.015)
Ring/T	0.083	0.083 (0.095)	– –
n_BULGE	1.08	1.08 (1.01)	0.219 (0.220)
R_EFF	12.3	11.9 (12.2)	11.4 (11.6)
r_EXPO	121	124 (121)	129 (126)
q_BAR	0.32	0.32 (0.33)	0.38 (0.37)
n_bar		0.70 (0.66)	0.92 (0.87)

EVEN MORE COMPONENTS? EXPERIMENTS WITH GALFIT3.0:

NGC1097: 5-component fit



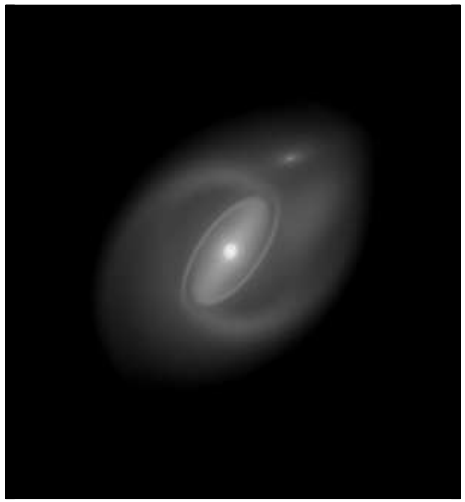
10-component GALFIT3.0 fit from v



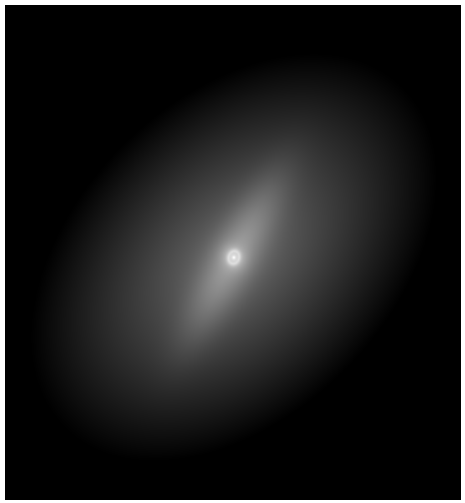
Which one to prefer?

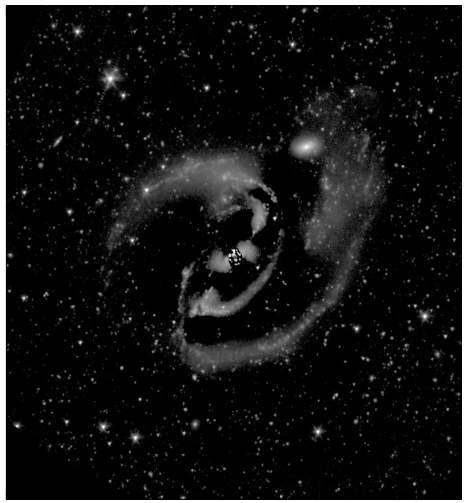
RESIDUALS:

galfit3_joannahs.fits



../HEIKKI_GALFIT3/ngc1097_galfit30.fits

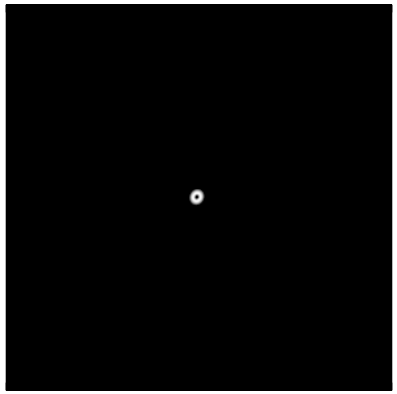




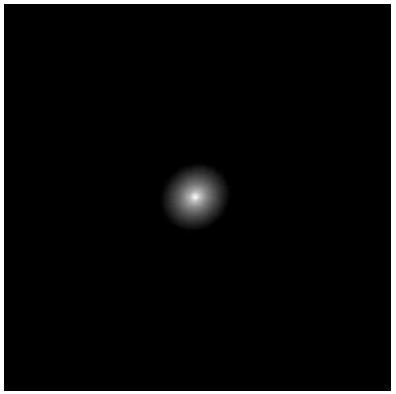
WHAT ARE THE MODELS IN THE 10 COMPONENT FIT?:

- **Actually only 5 components for NGC 1097 (in Chien's model from wiki)**
  ring, spirals require 2 components each, 2 describe the companion + extra light

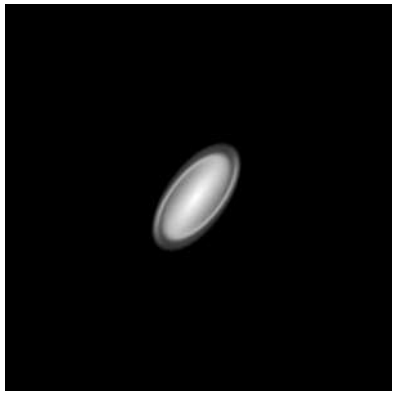
NR



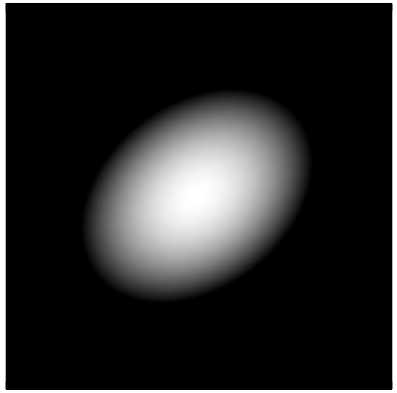
BULGE



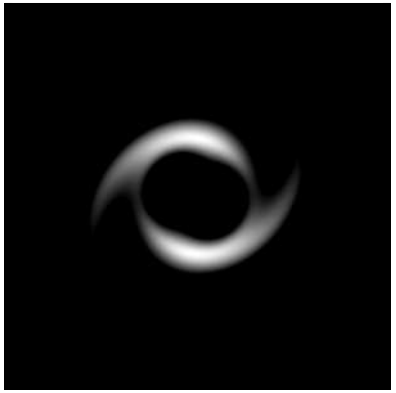
BAR+INNER SPIRAL



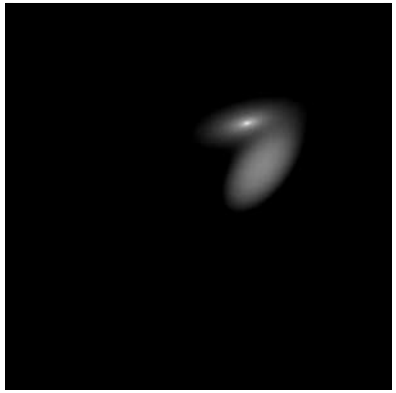
DISK



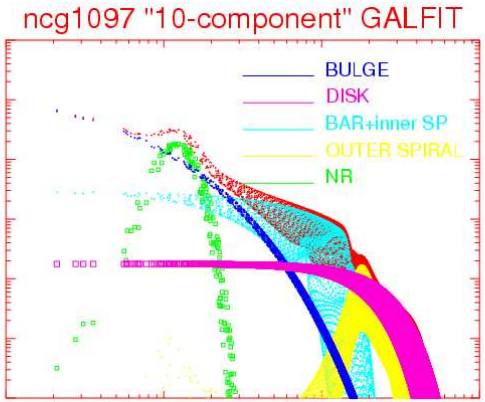
OUTER SPIRAL

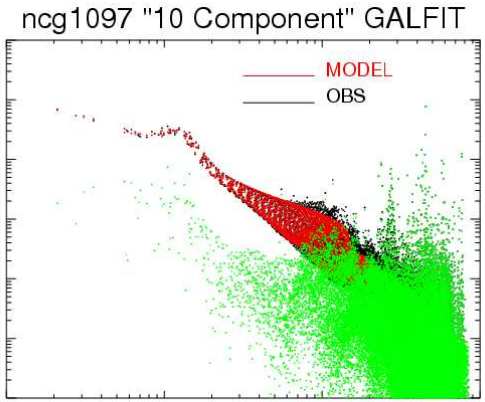


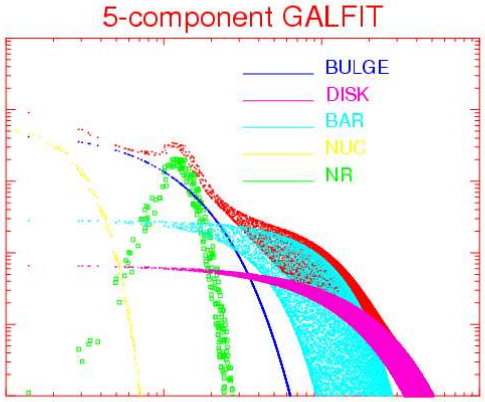
COMPANION

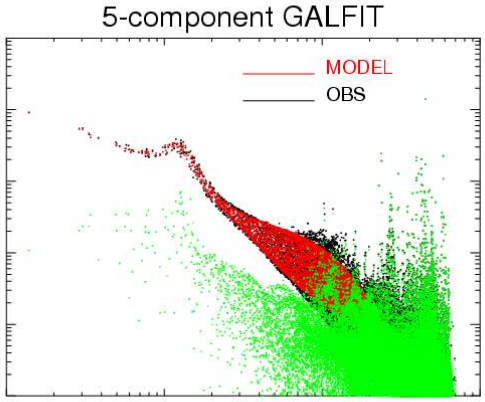


SAME MODELS DISPLAYED AS MAG VS. DISTANCE ALONG SKY:





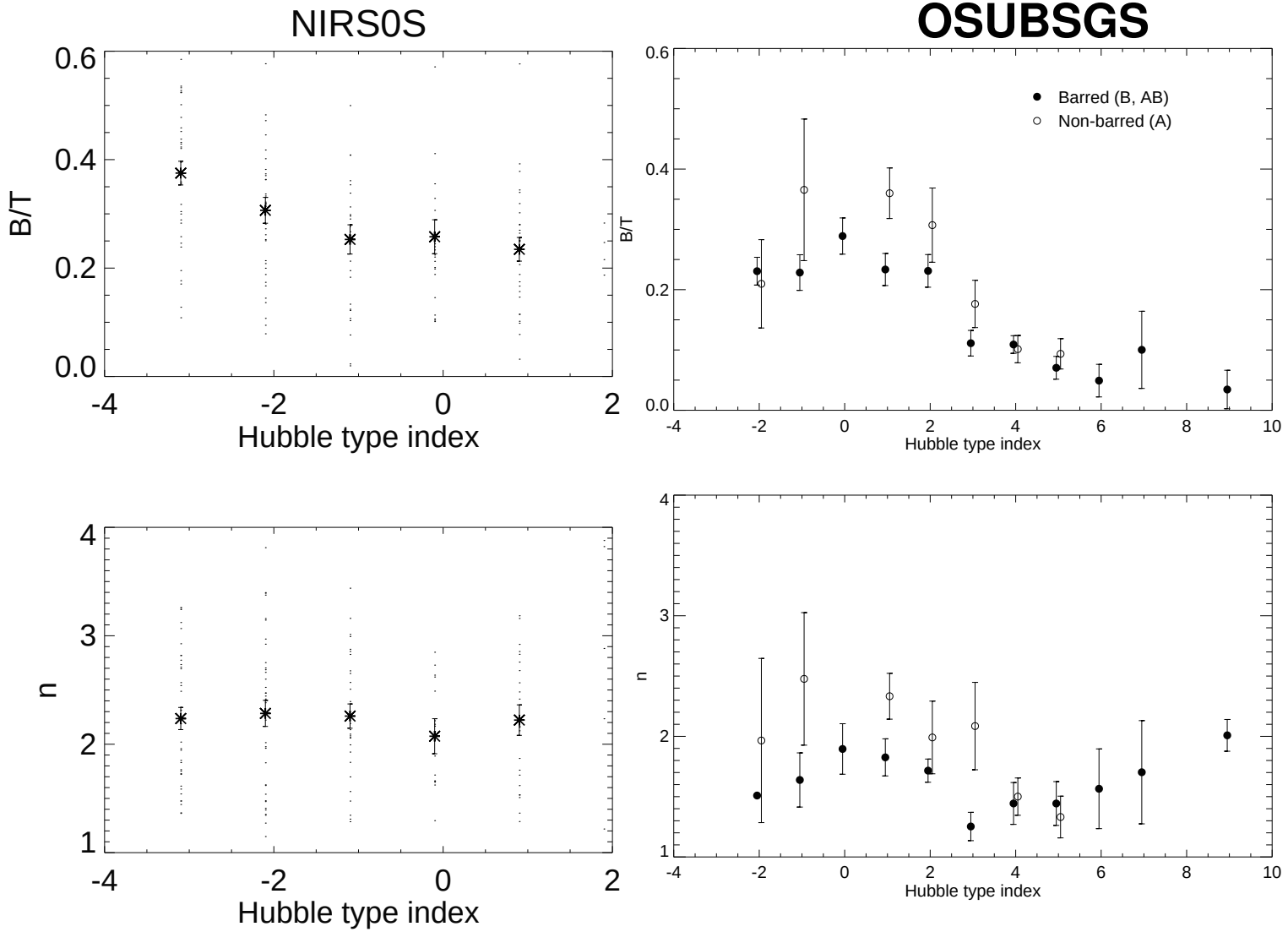




⇒ **Fairly similar compared to the simpler 5-comp fit!**
except that the outer spiral is extra, central point source is missing,
and the bulge is more exponential (n=1.8 instead of 1)

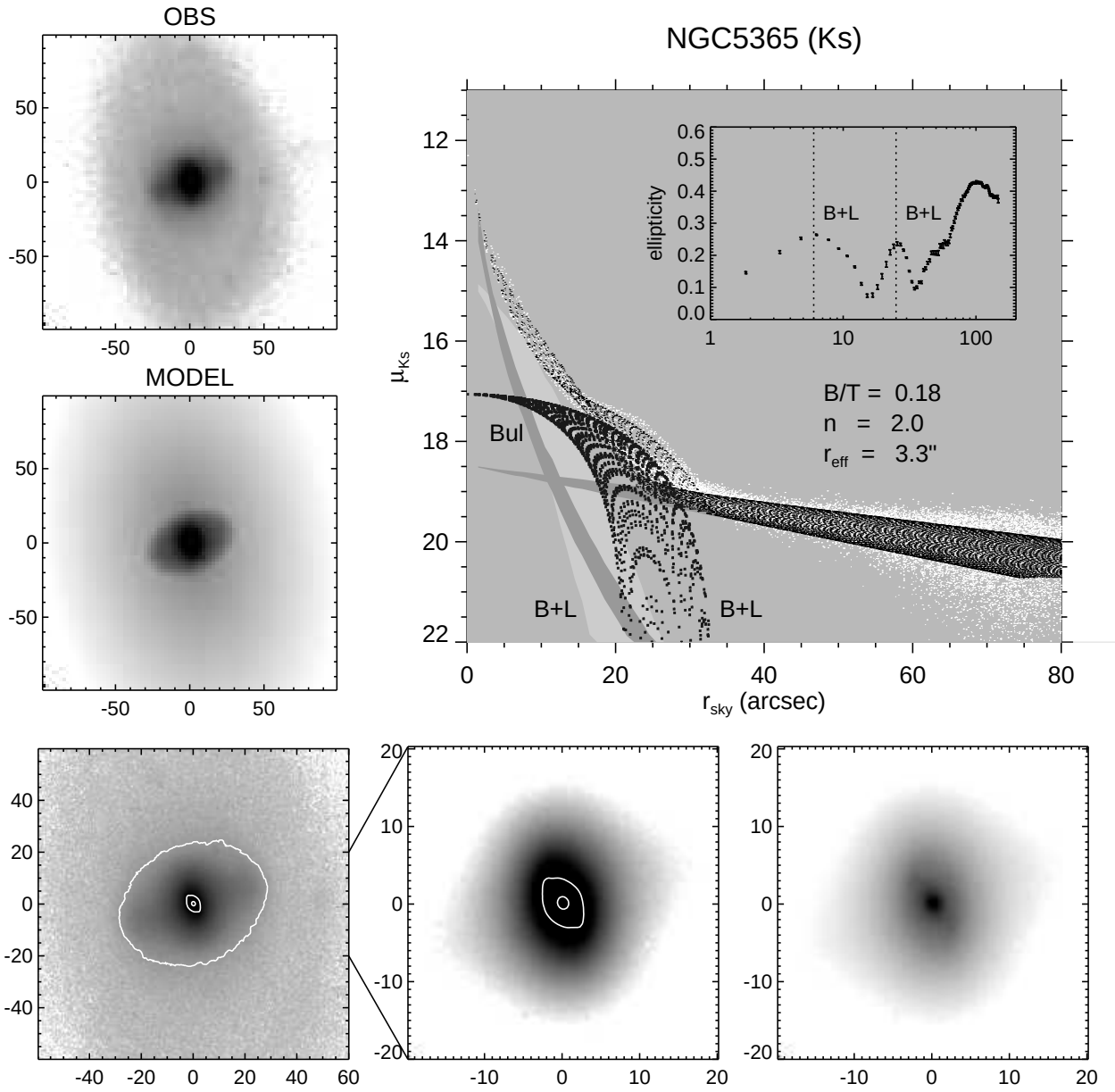
	5-comp model	"10-comp"
Bulg/T	0.187	0.270
Disk/T	0.417	0.246+0.0072=0.32 (Disk+outer spirals)
Bar /T	0.288	0.307
Nucl/T	0.012	
Ring/T	0.095	0.103
n_BULGE	1.01	1.82
R_EFF	12.2	15.7
r_EXPO	121	Disk is not exponential

PREVIOUS APPLICATIONS OF BDBAR: BULGE PROPERTIES IN OSUBSGS AND NIRSOS SAMPLES



NIRS0S: FITTING MULTIPLE OVAL COMPONENTS IN S0'S

(LAURIKAINEN, SALO, BUTA, KNAPEN 2009 APJL 692, 34)



ABOUT GENERAL FITTING STRATEGY

- **Only components which correspond to a physical structure in the image should be included to fits**
- **Start with simple fits, proceed stepwise to more complicated models**

  $\Rightarrow$ **Bulge/disk/bars/ovals/rings (if present) for all Hubble type disk galaxies,**

  $\Rightarrow$ **strong spiral arms for late-type galaxies**
- **Important to remember: goal is to estimate properties of physical components (e.g. exponential disk), rather than get rid of all the residuals.**

PERHAPS DIVIDE TASKS AS:

Bulge/disk and bulge/disk/bar: BUDDA?

Multi-component decompositions: GALFIT, BDBAR?

- **Important to use with all codes the same PSF, Mask-images, σ-images**

HOW TO MAKE RESULTS OF DECOMPOSITIONS AVAILABLE

- **Table of fitting parameters**

  Bulge: $Bar/T, n, r_{\rm eff}, \mu_0, b/a, \phi$

  Disk: $Disk/T, h_r, \mu_0$

  Bar/oval: $Bul/T, n, r_{\rm eff}, \mu_0, b/a, \phi$

  Ring: $Ring/T, a, b, W, \phi$

  Point source: Nuc/T

  - The shape parameters (boxy/disky) probably not very reliable (bars: affected by spirals etc)

  - Same concerns 'bar length': model estimate bad as bars usually more complicated than models. Bar length needs to be estimated by other (several!) methods.

  - Also, stick with luminosities in pipeline III products (M/L conversions can be done separately)

- **Figures (plots+electronic) including**

  Fit to the surfac brightness profile (mag vs sky distance from center)

  Model image, ObservedImage, Residual Image