

Breaking mass-anisotropy degeneracy in dwarf spheroidal galaxies (or: Why proper motions are awesome)

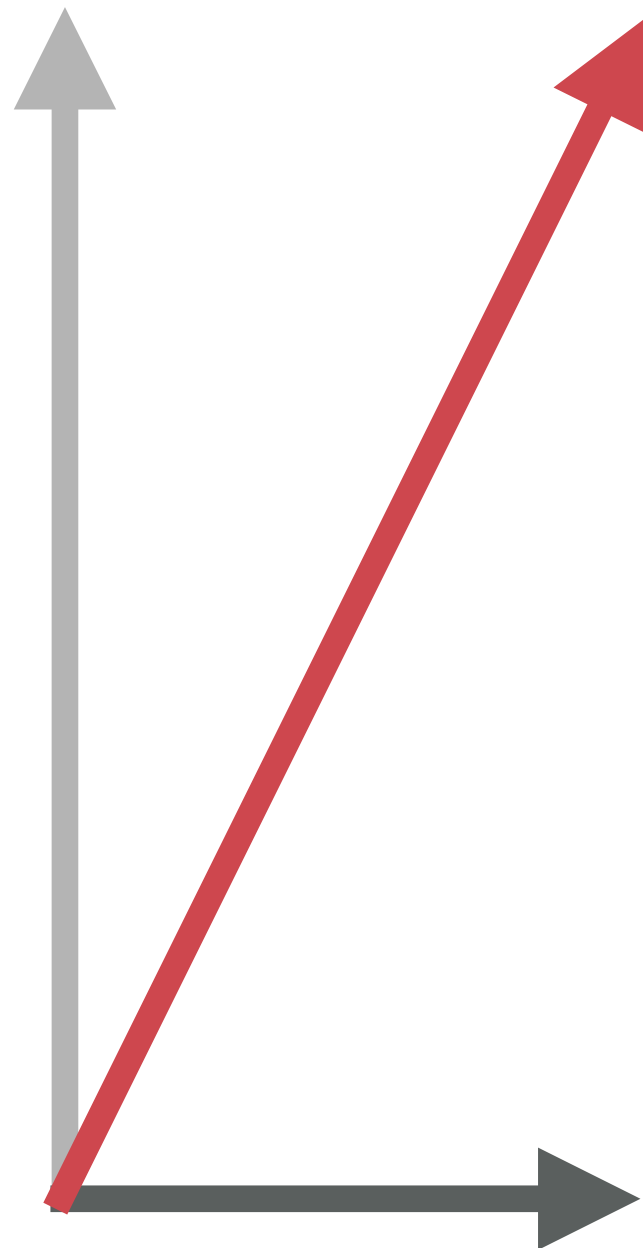
Laura Watkins · STScI

 @laurawatkins_

Justin Read, Gary Mamon, Matt Walker
+ Spherical/Triaxial Systems working group

velocity anisotropy

mass-anisotropy degeneracy



mass estimates require **total** velocity

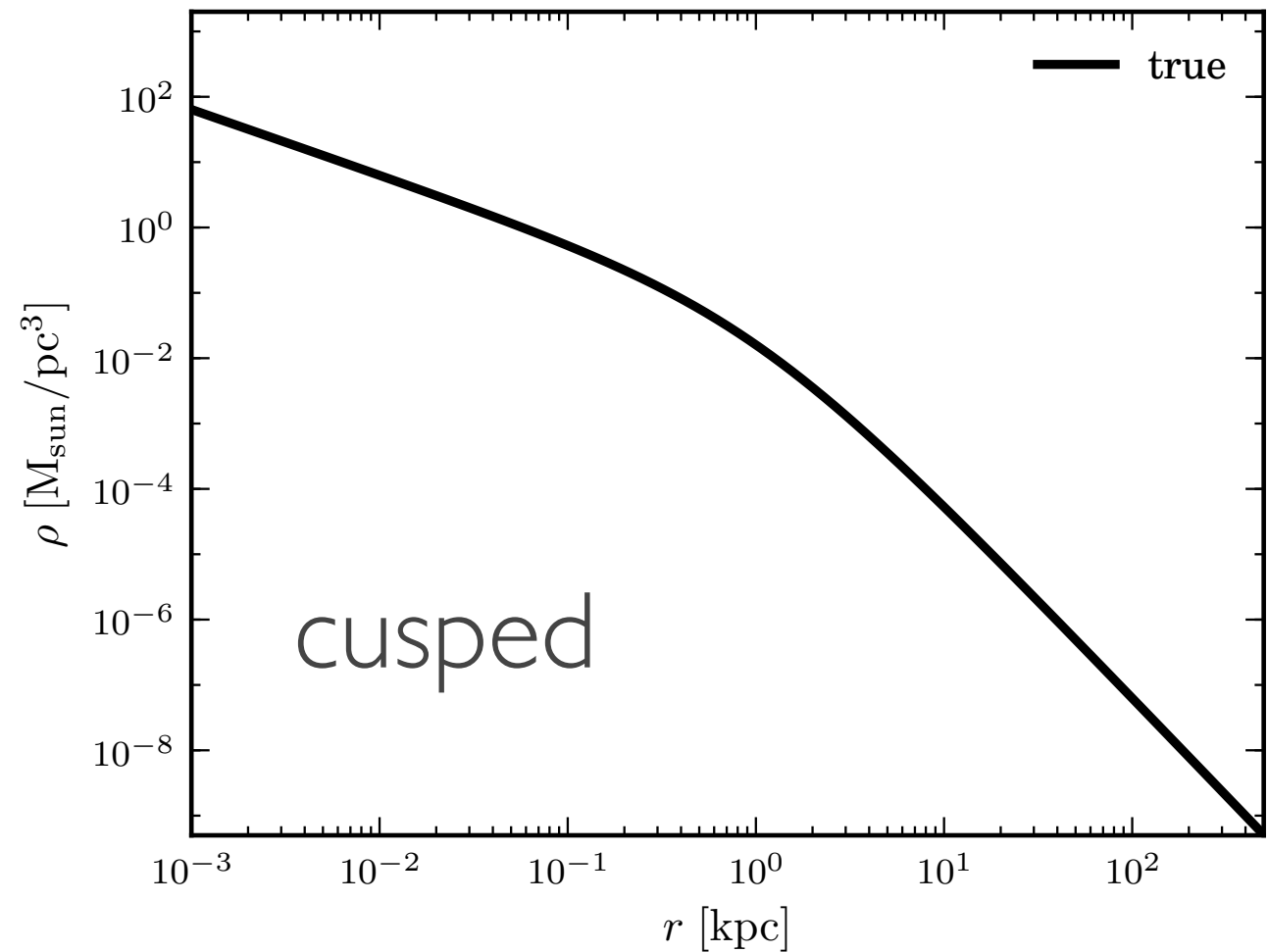
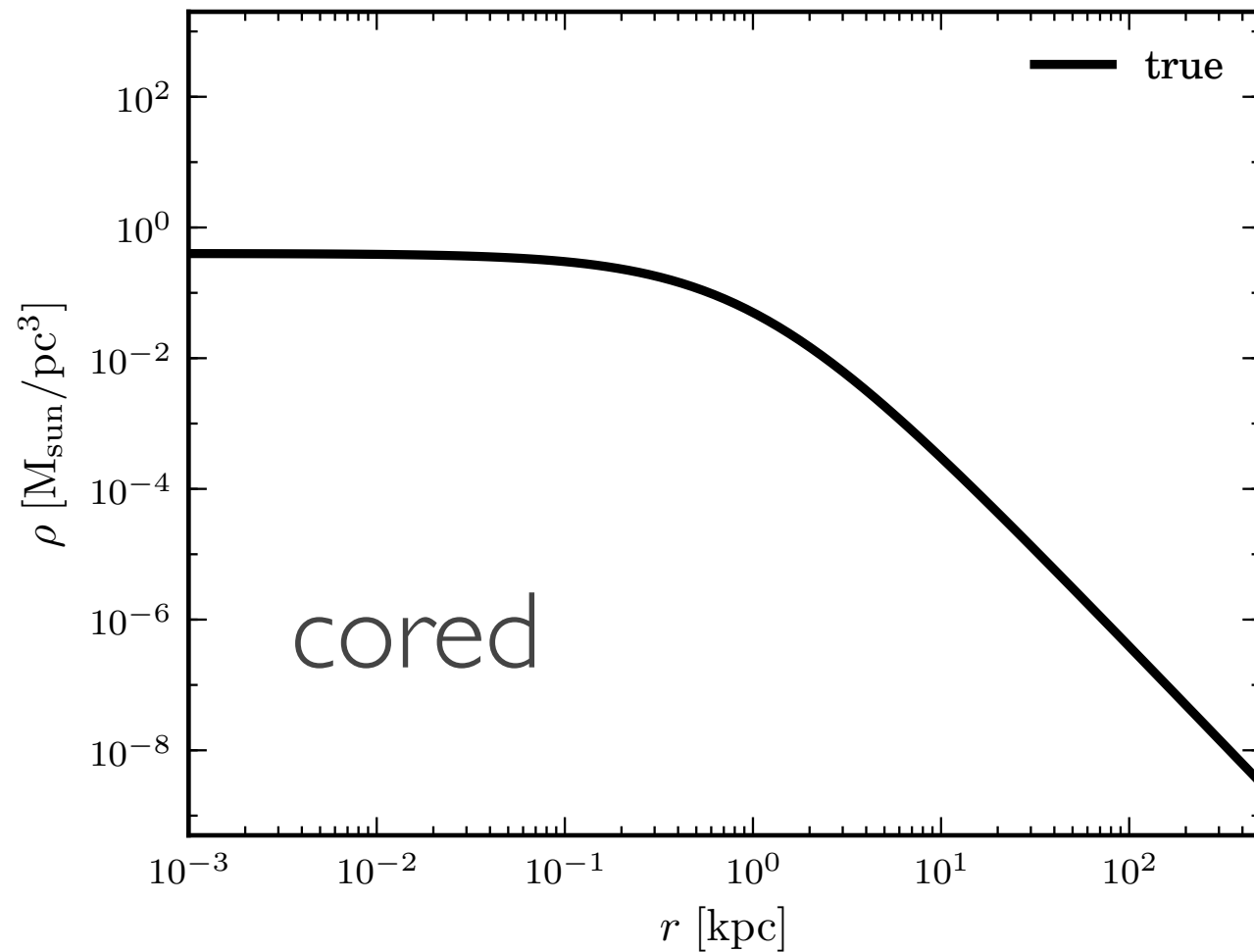


are dwarf spheroidal
DM profiles
cored or cusped?

how much do
proper motions
really help?

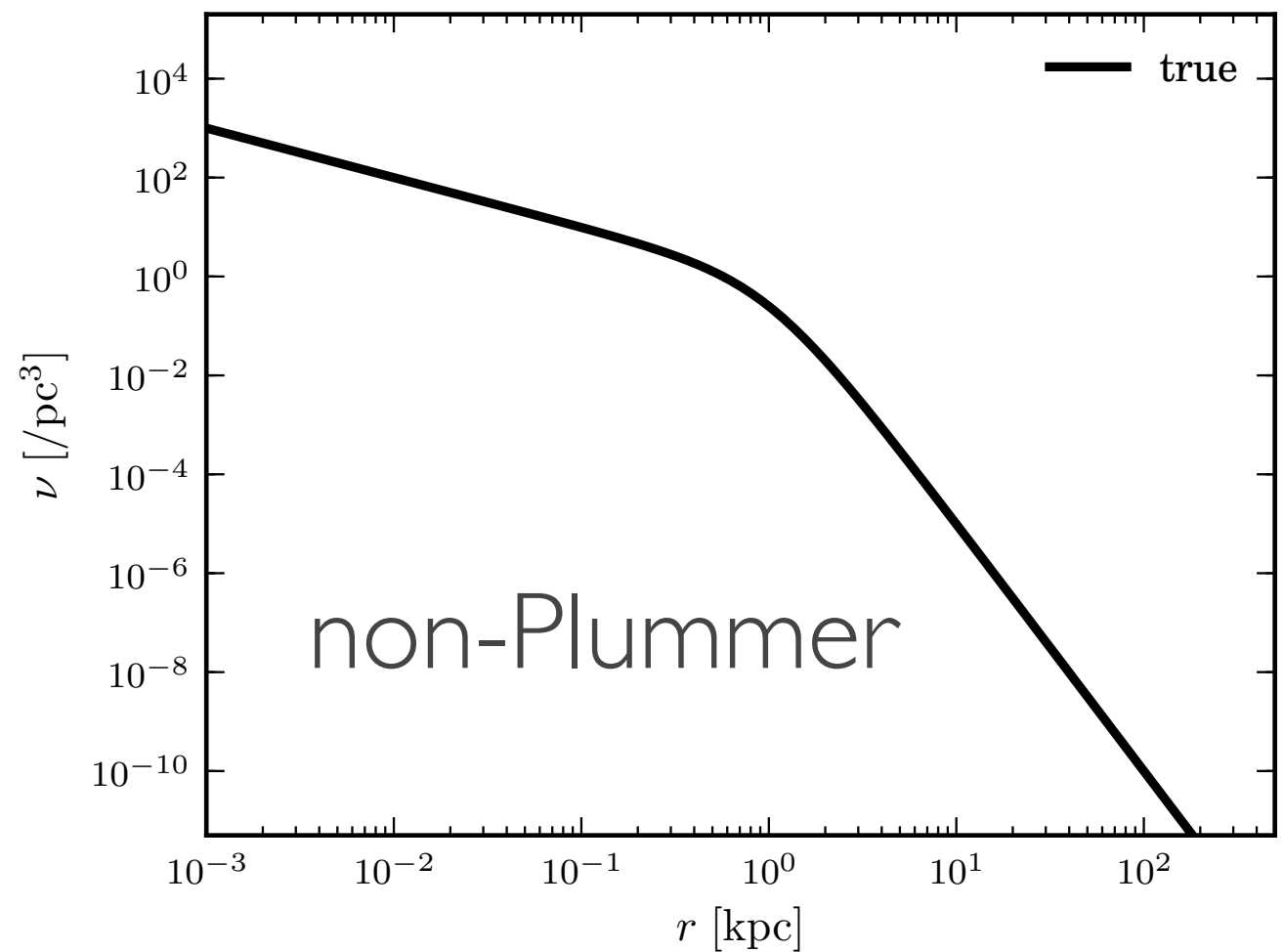
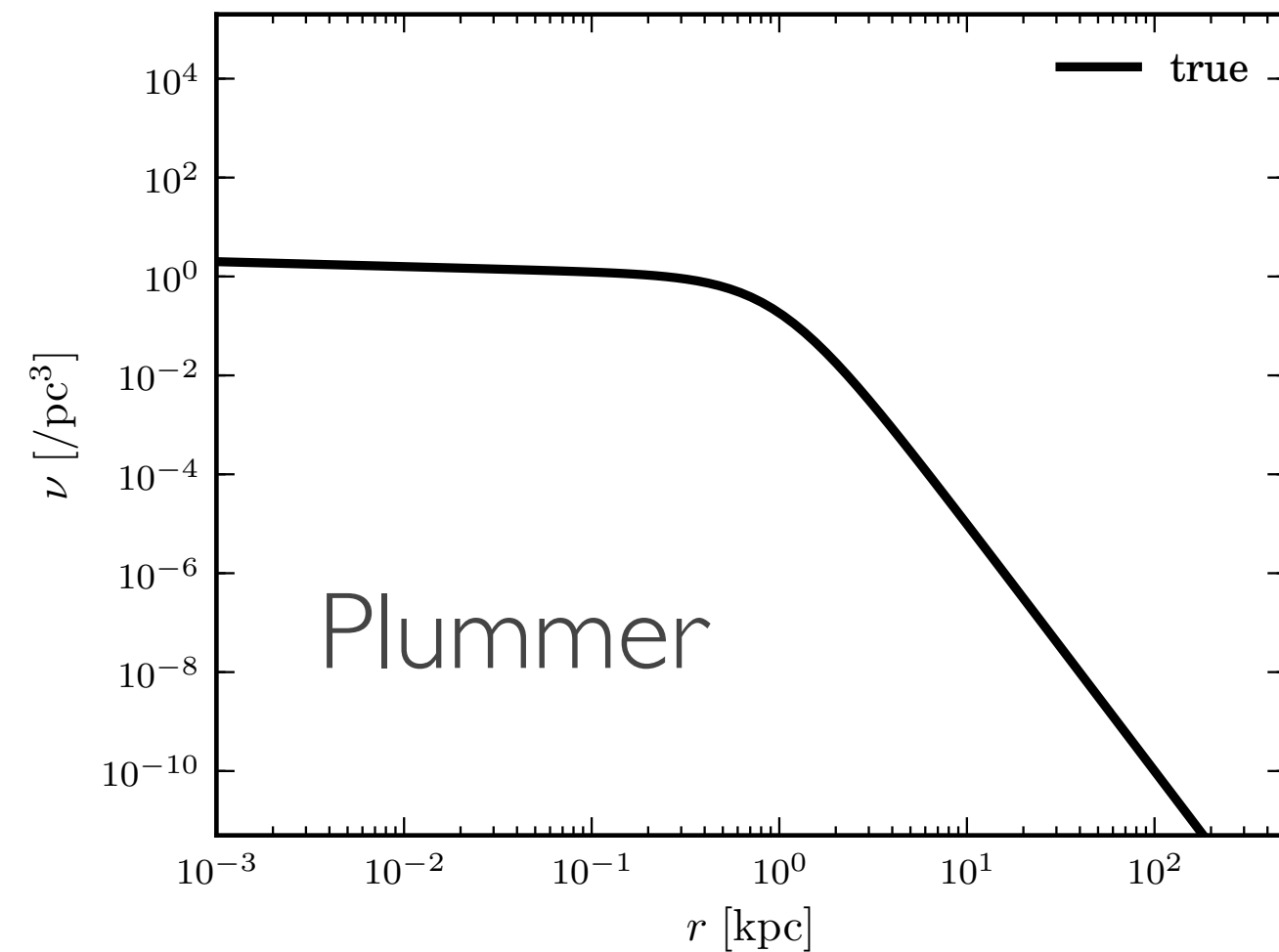
spherical test problems

dark matter density profiles



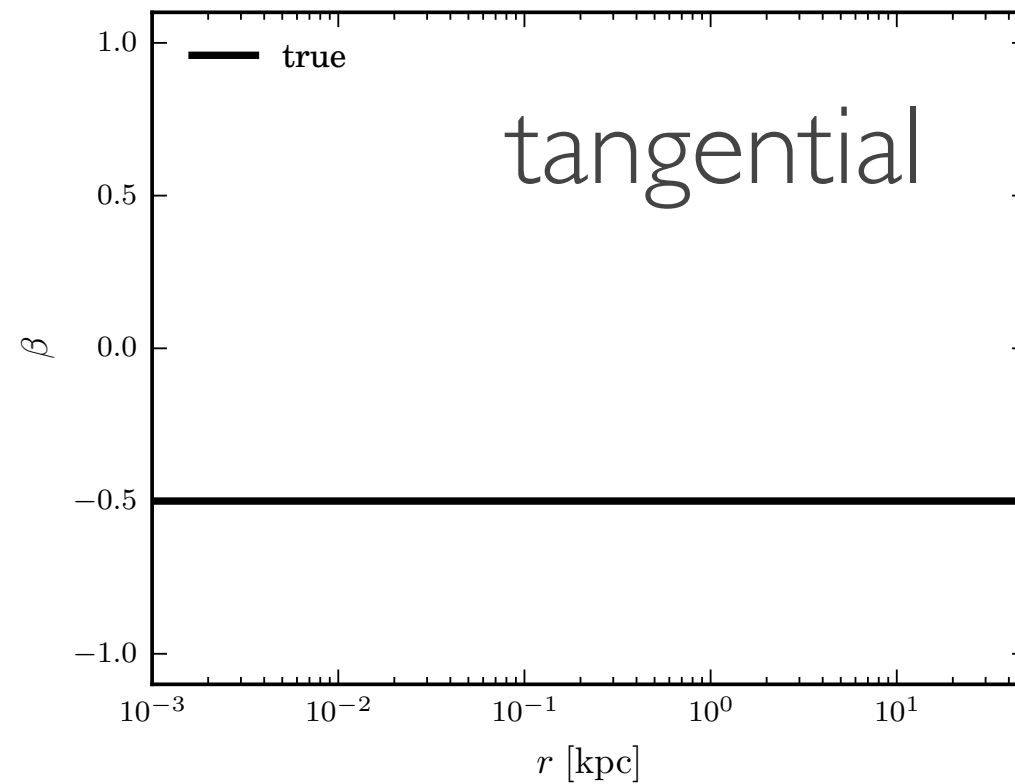
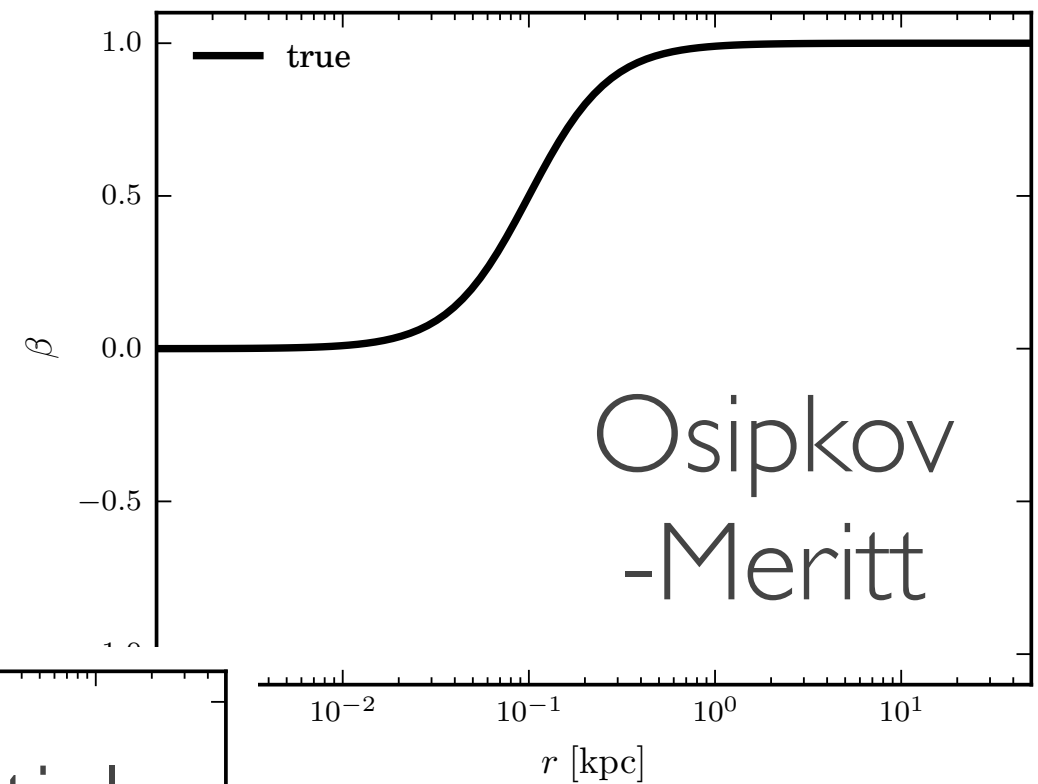
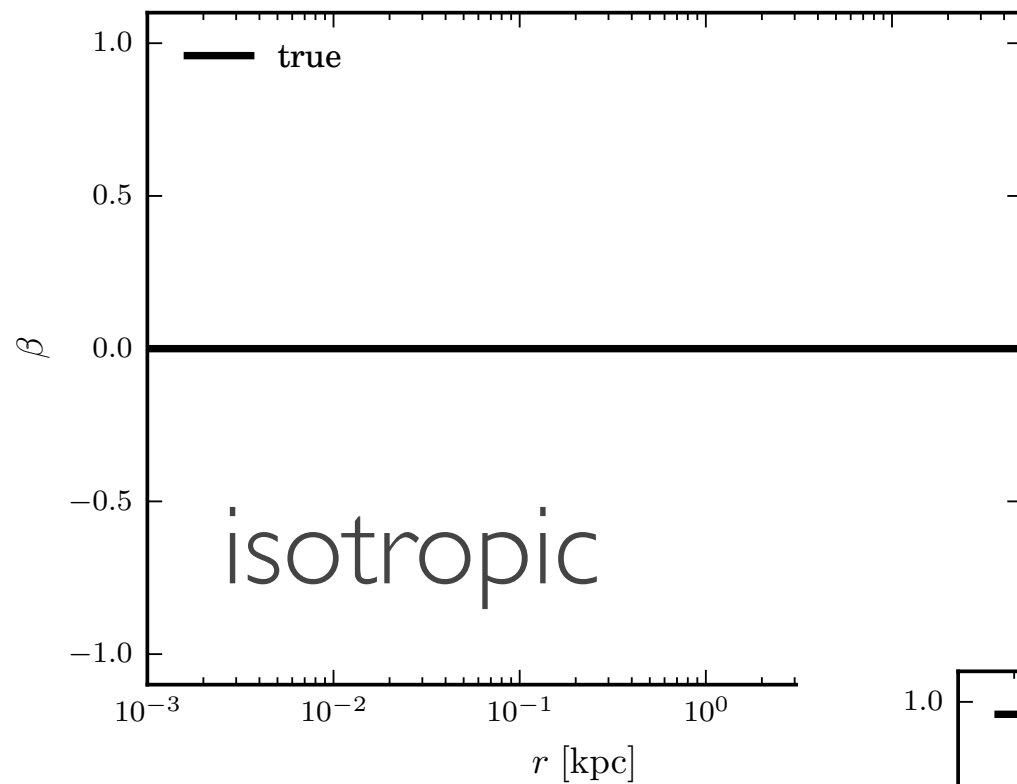
3 ~~5~~ free parameters: ρ_0 , r_{DM} , ~~α_{DM}~~ , ~~β_{DM}~~ , γ_{DM}

tracer density profiles



~~4 free parameters: r_* , α_* , β_* , γ_*~~

anisotropy profiles

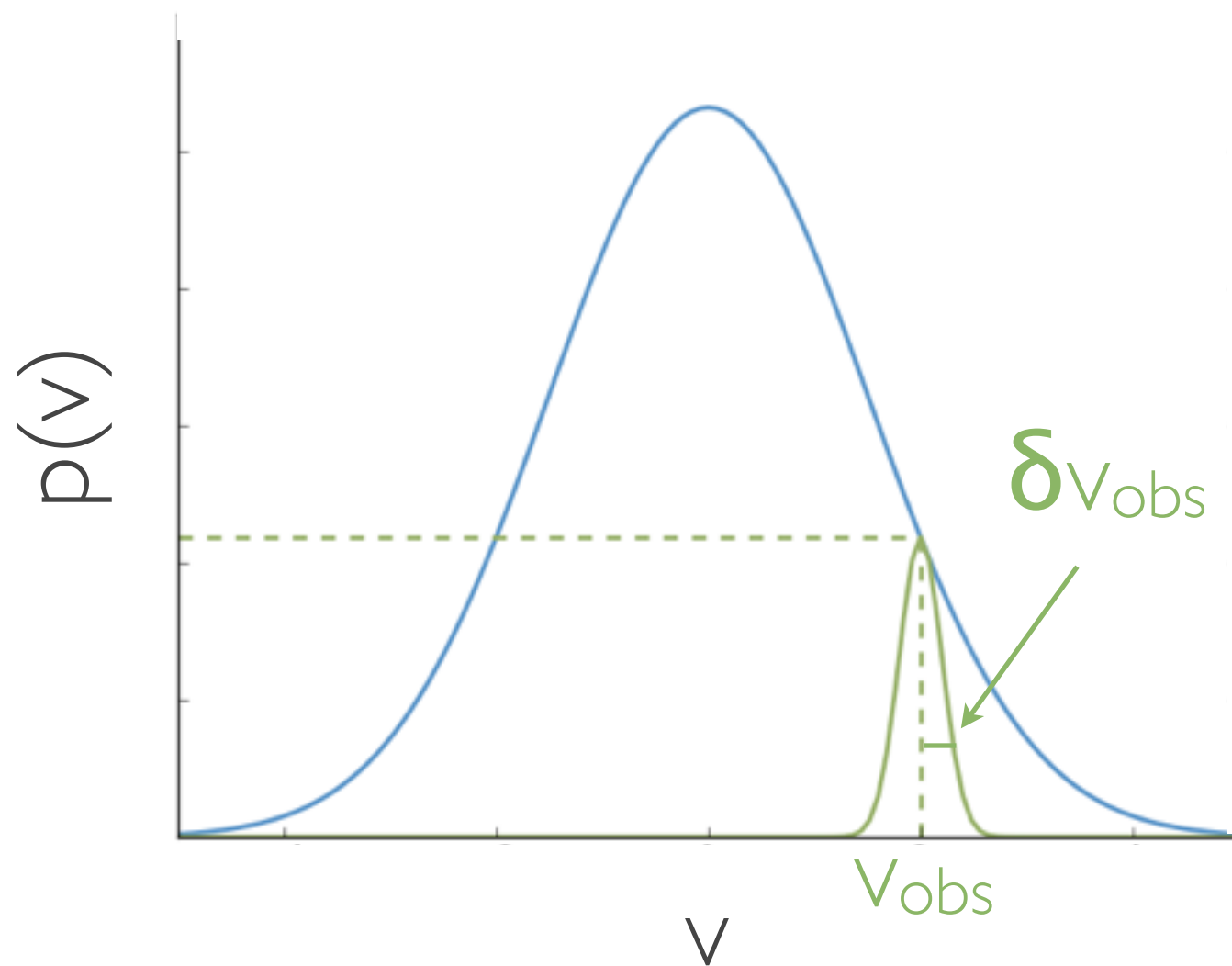


2 ~~X~~ free parameters: ~~X~~ β_0 , β_∞

discrete models

individual stars

spherical anisotropic Jeans models

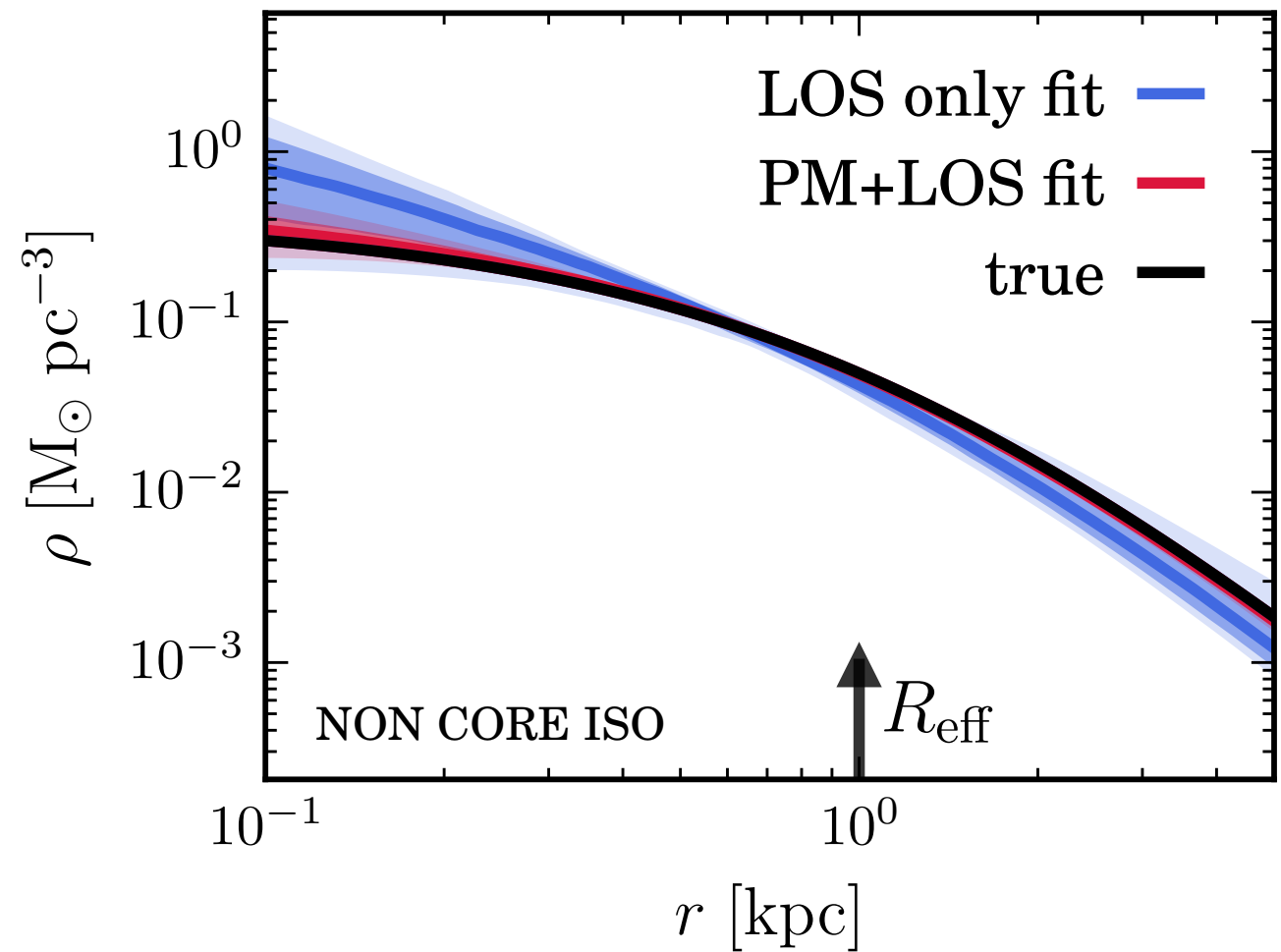
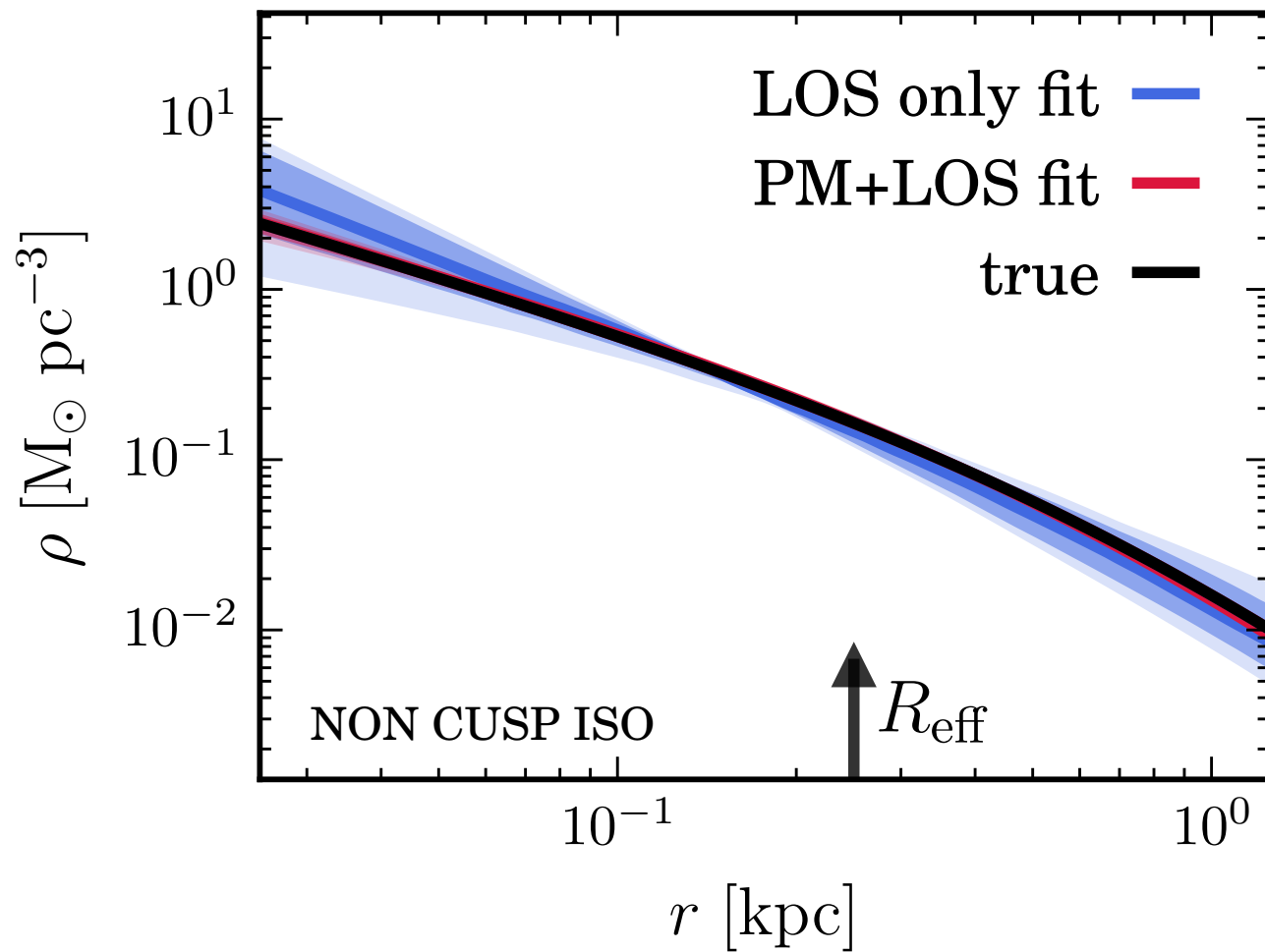


at position of star

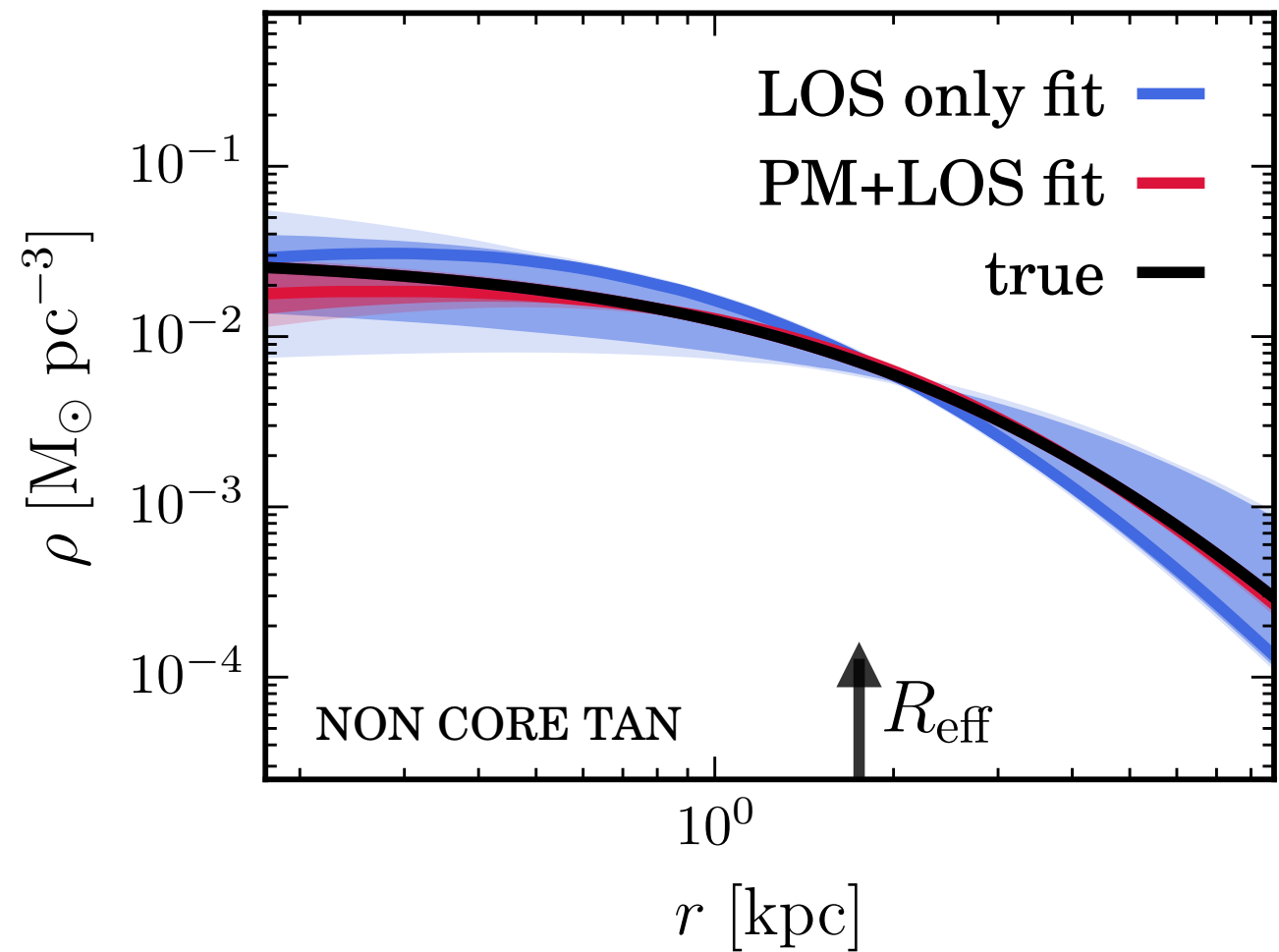
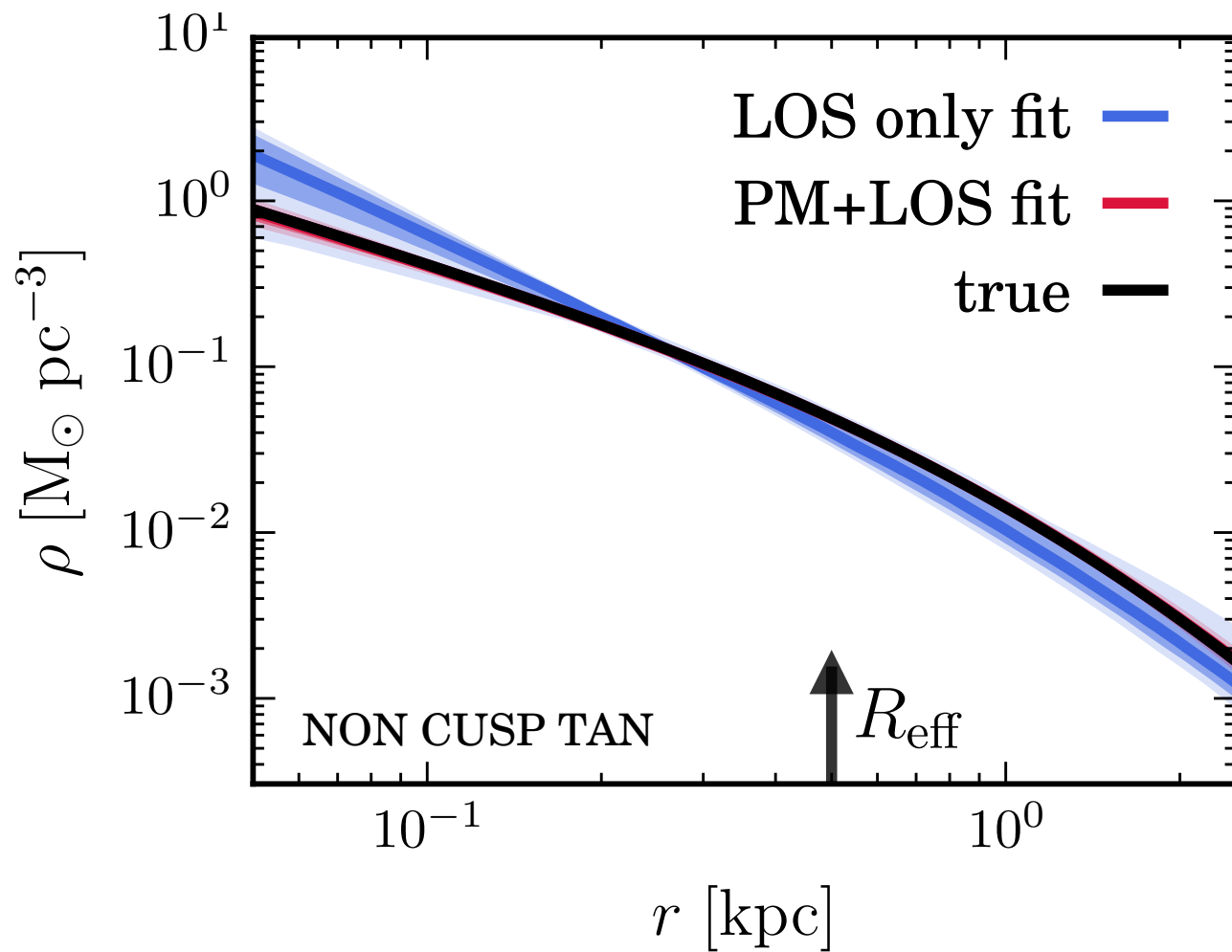
$$p(v_{\text{obs}} \mid \text{model}, \delta v_{\text{obs}})$$

improvements with
proper motions

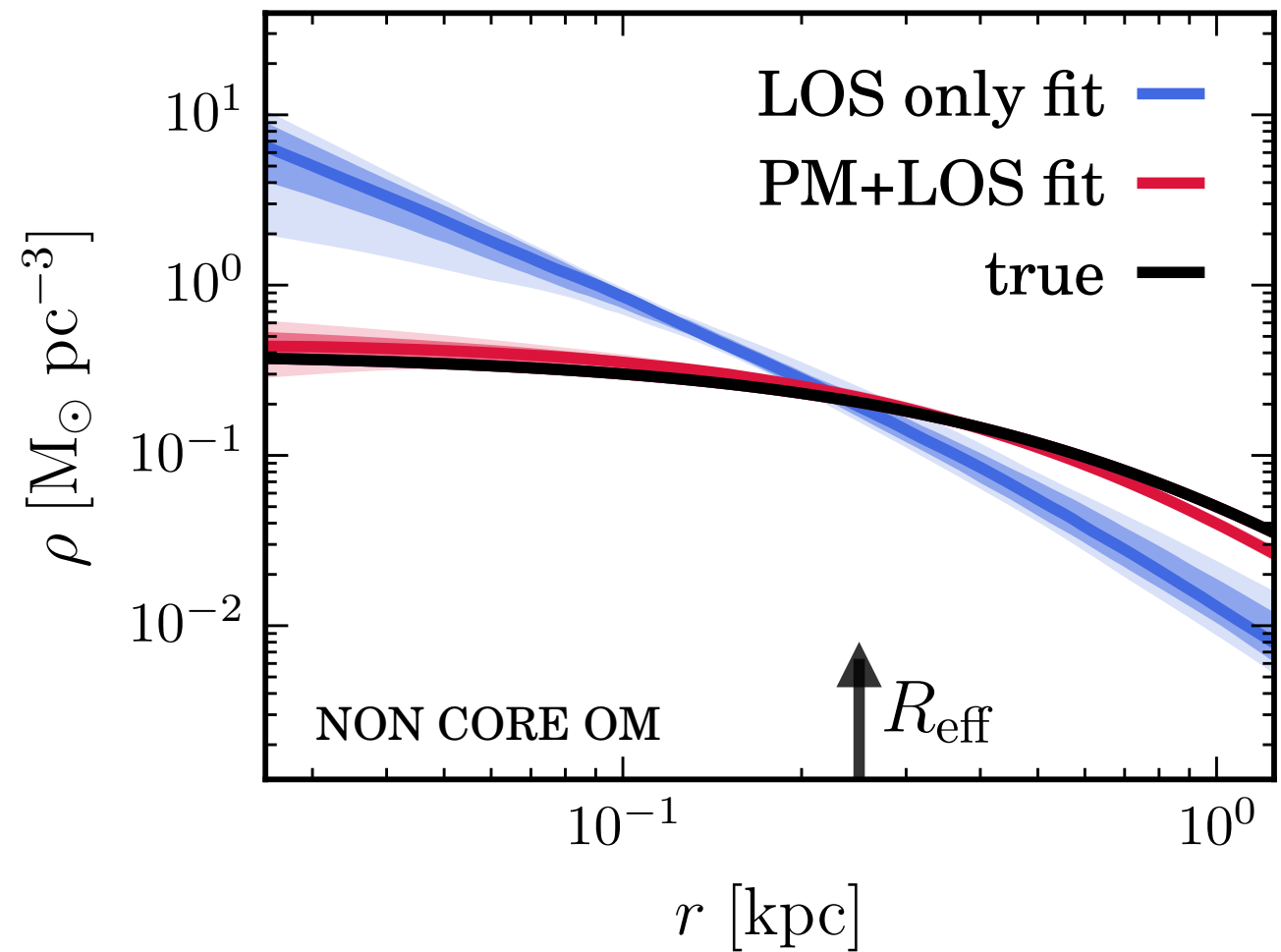
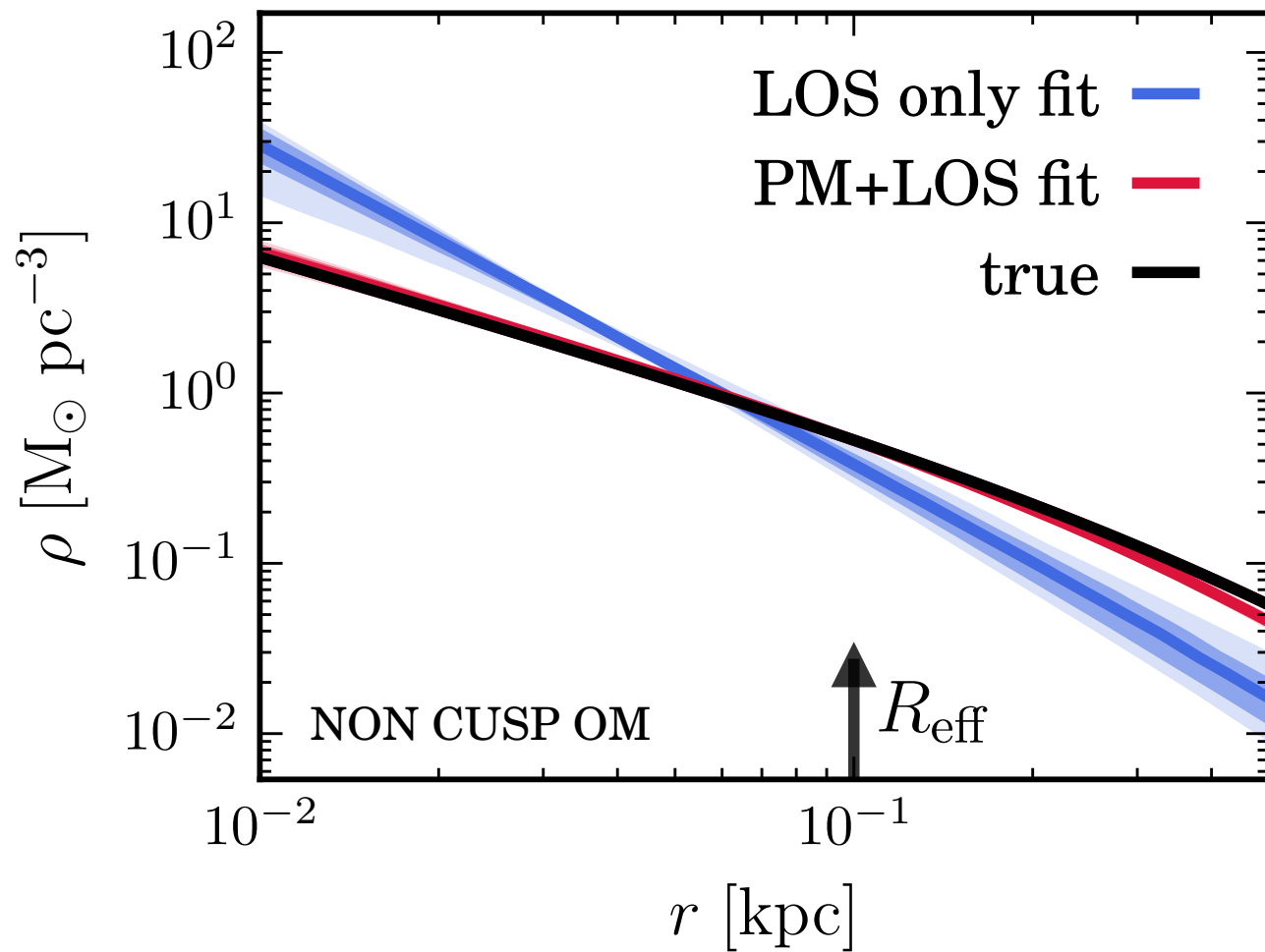
10,000 stars | isotropic



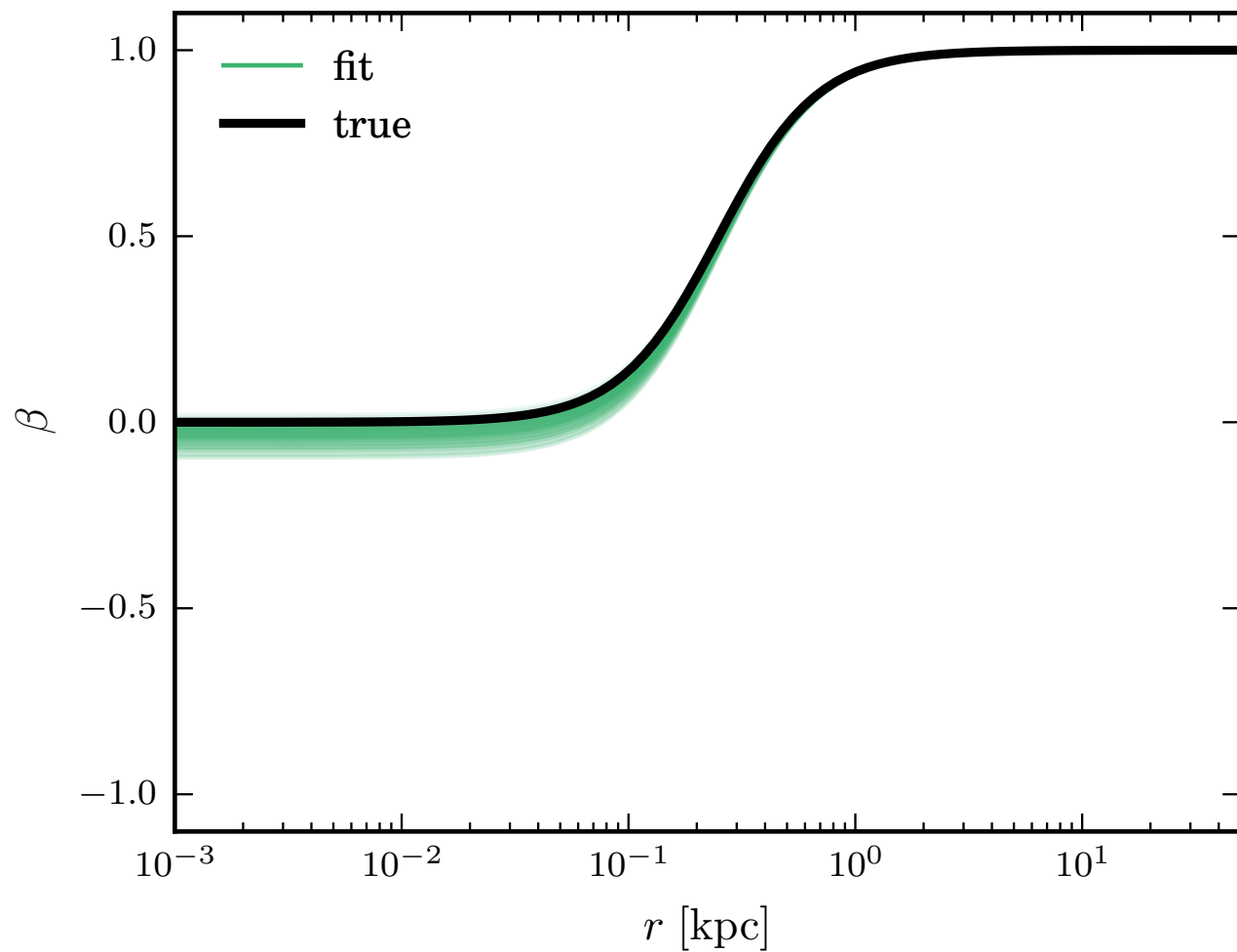
10,000 stars | tangential



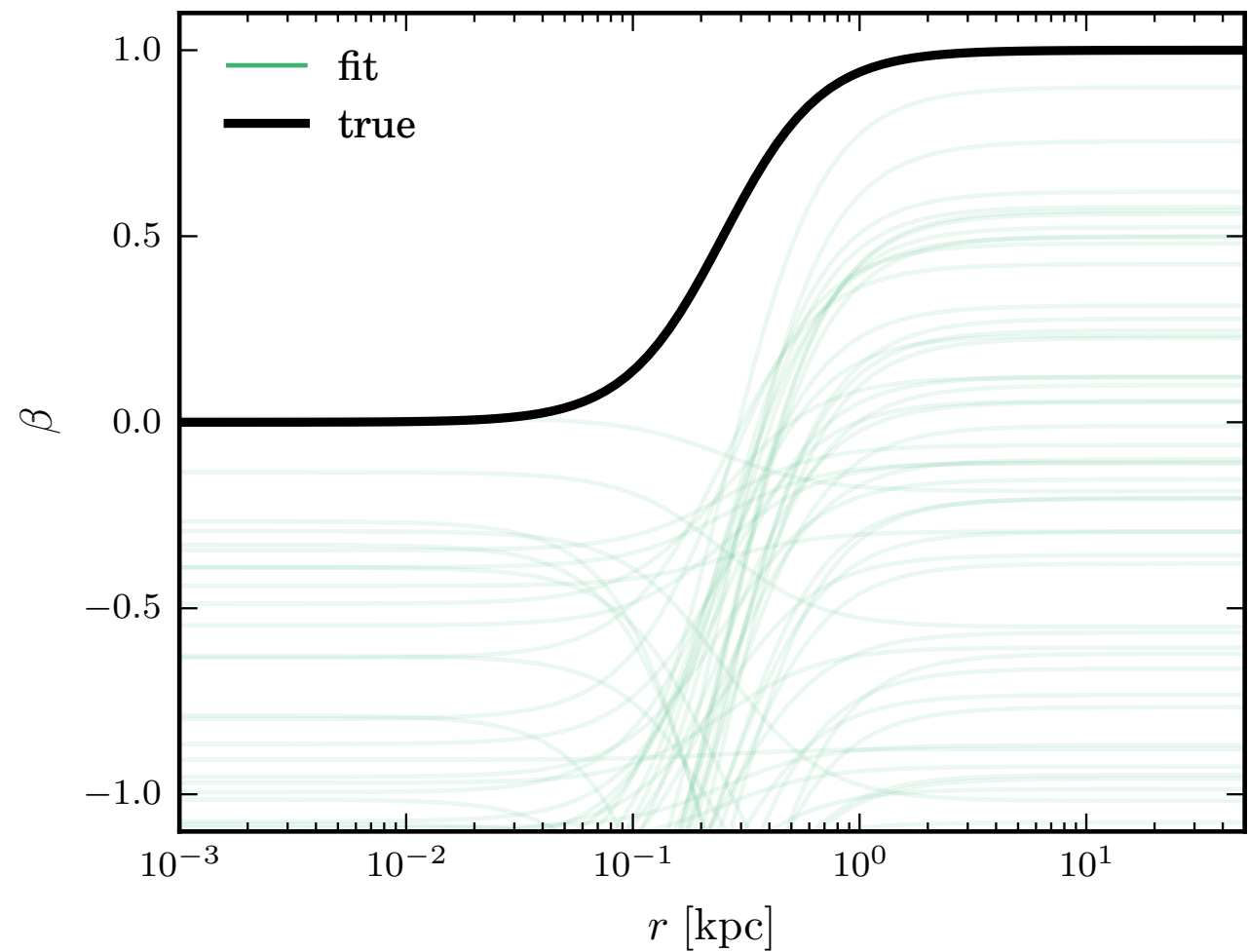
10,000 stars | outer radial



10,000 stars | outer radial

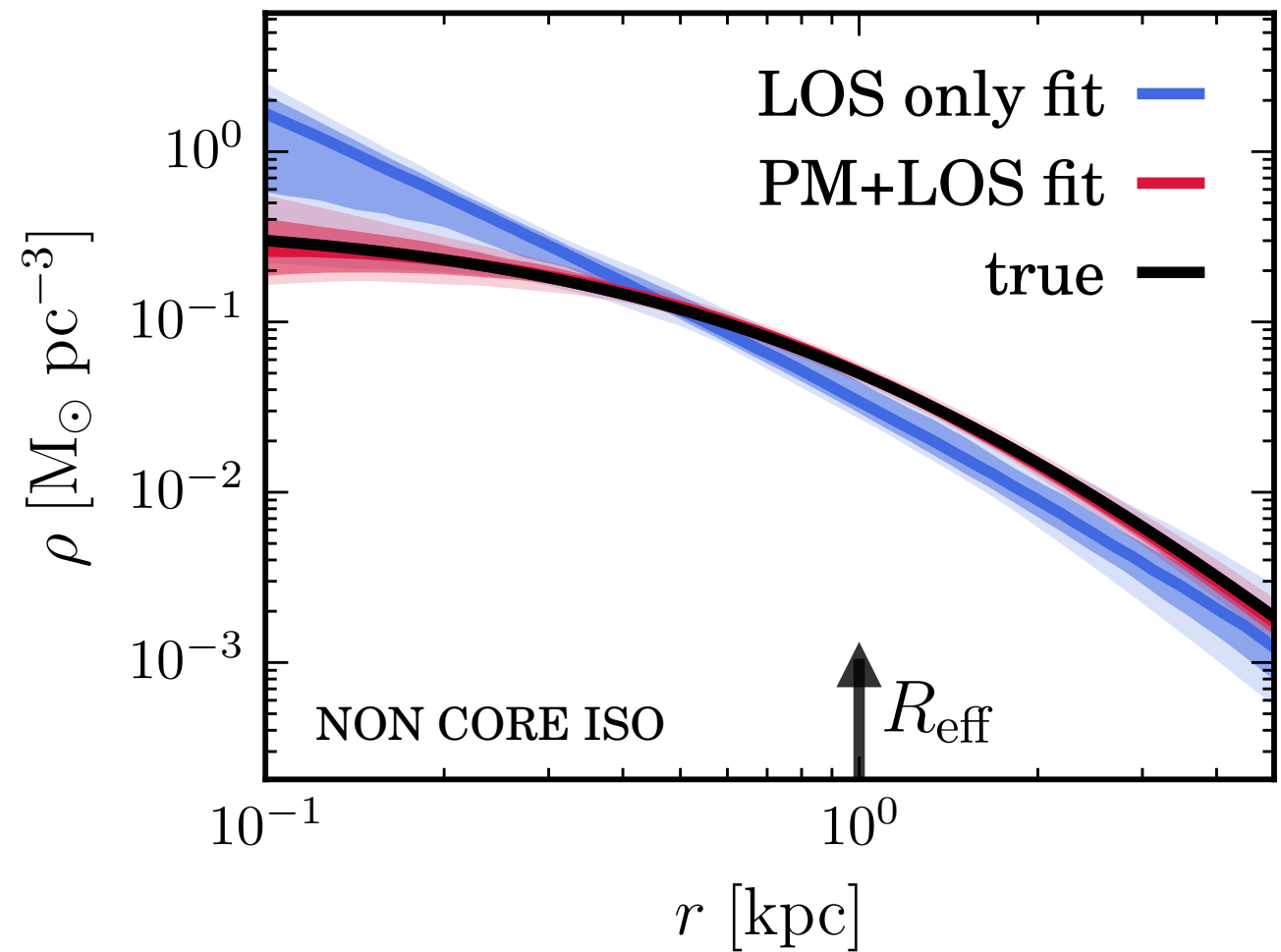
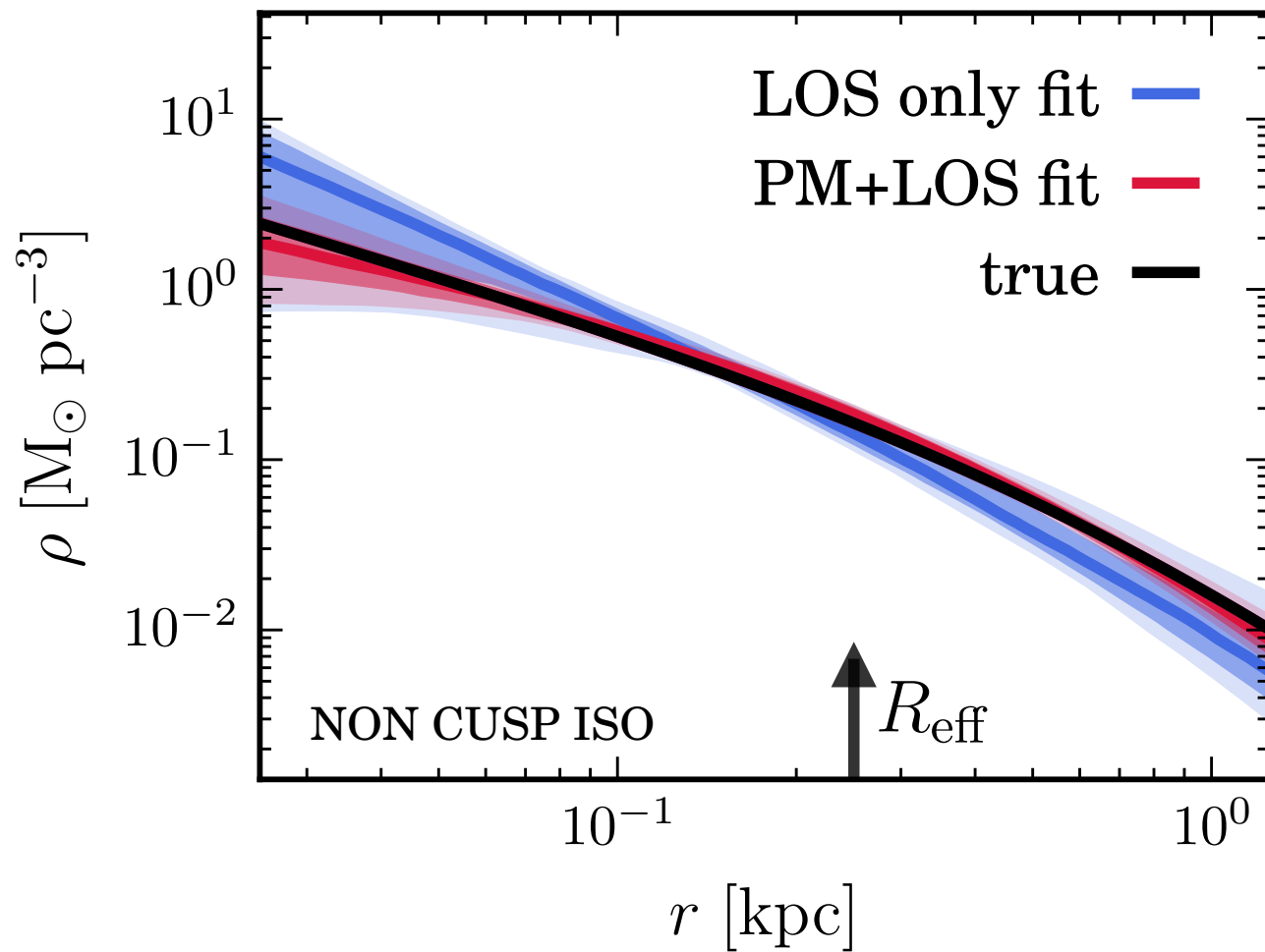


LOS + PM

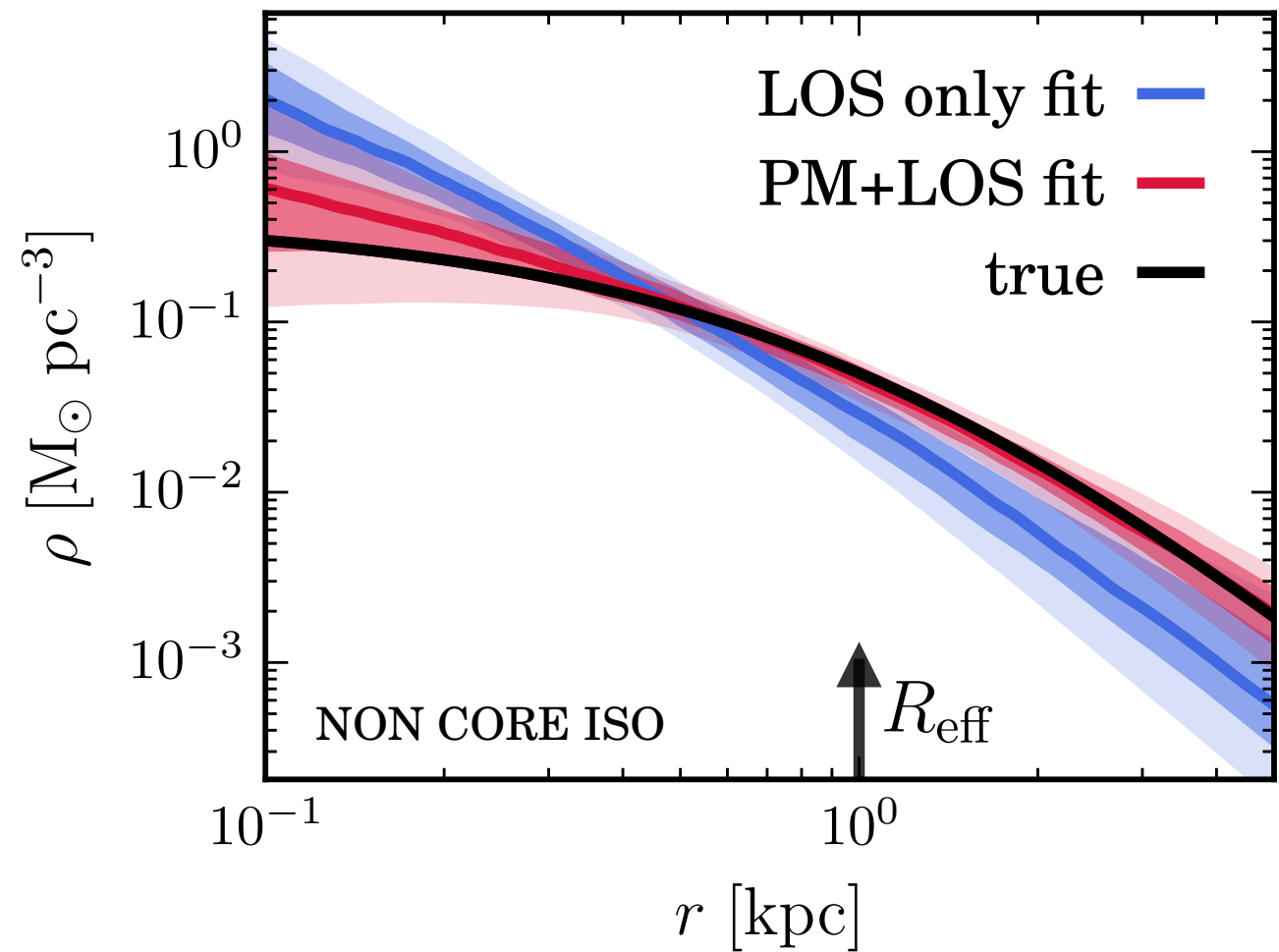
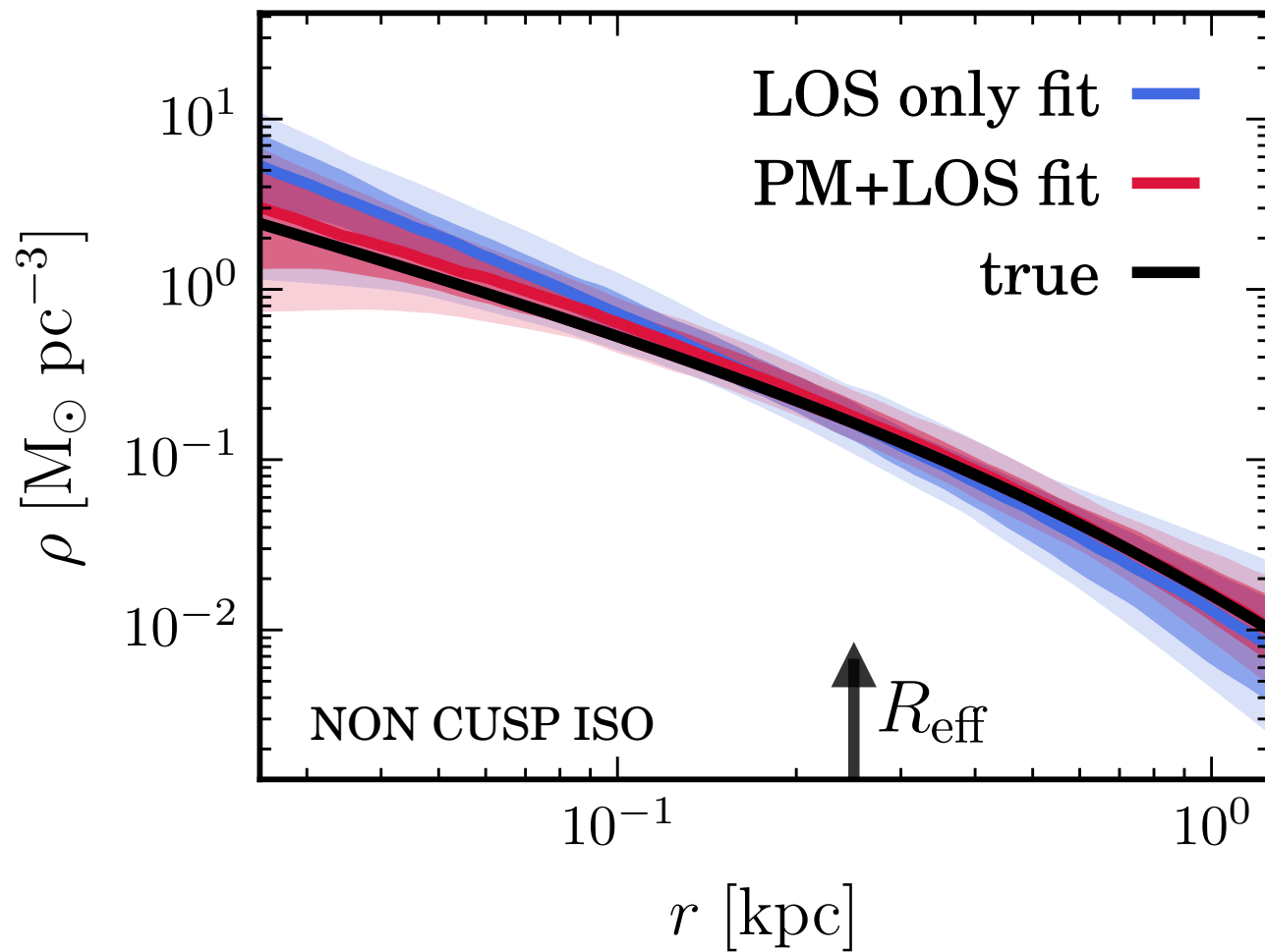


LOS only

1,000 stars | isotropic

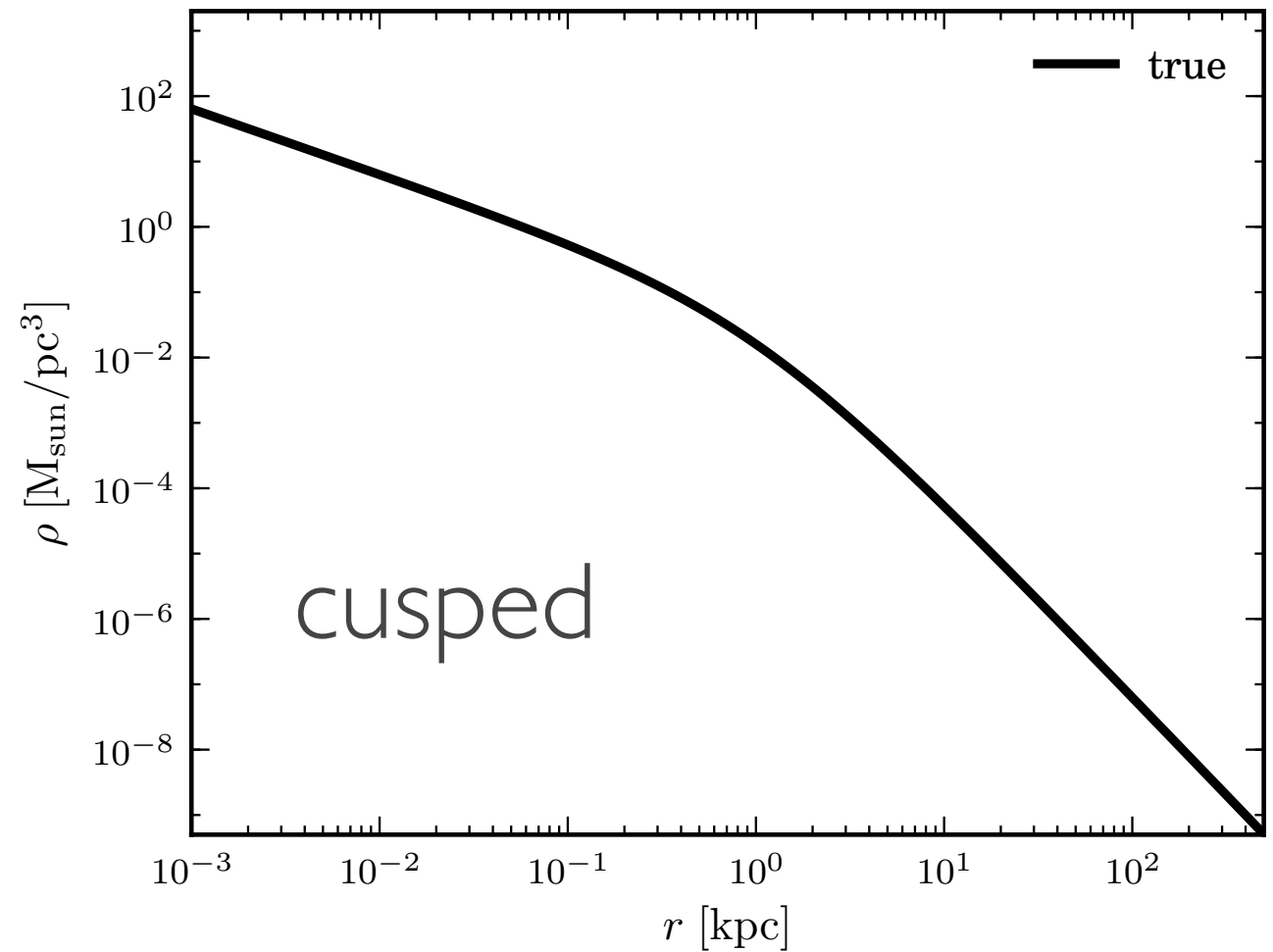
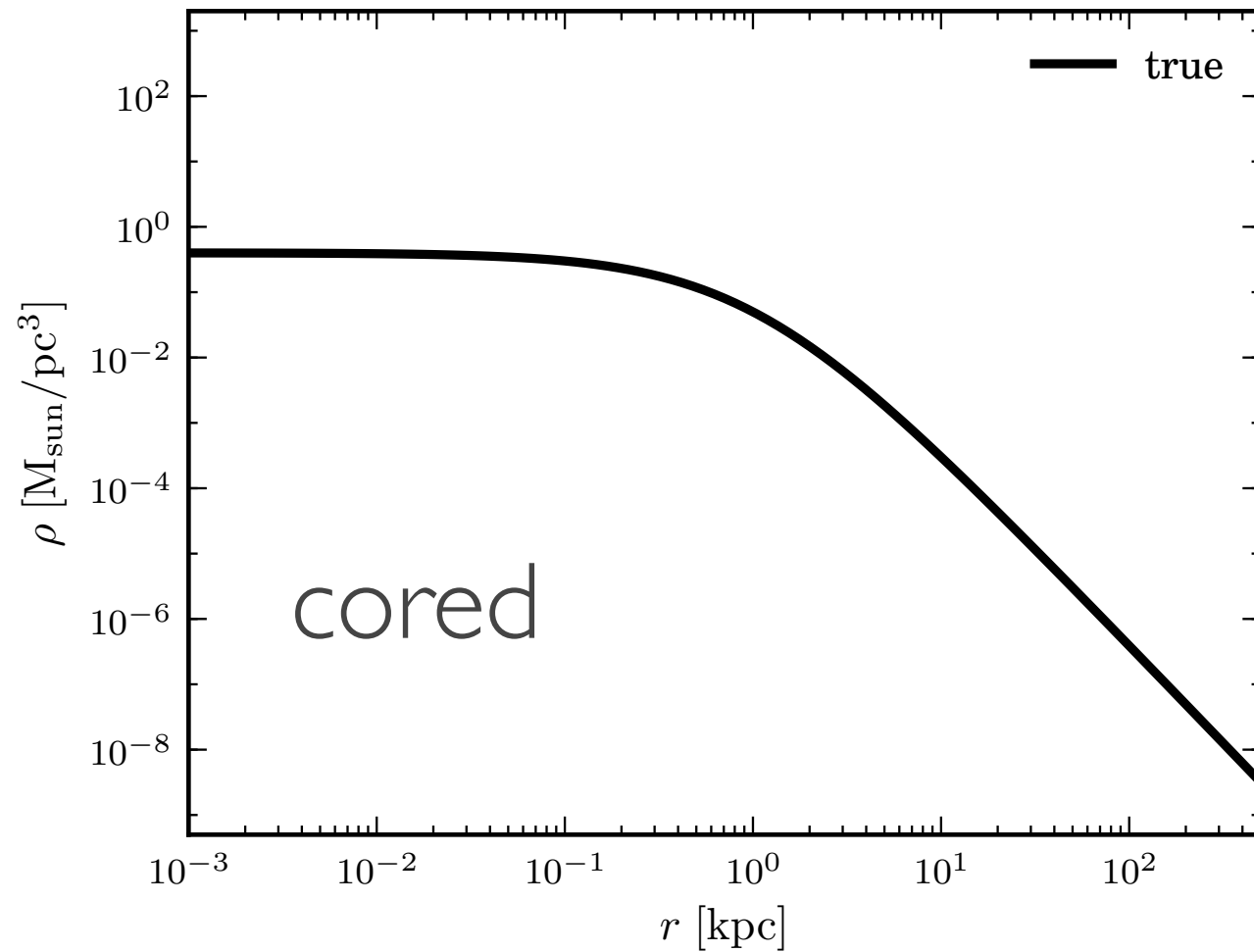


100 stars | isotropic

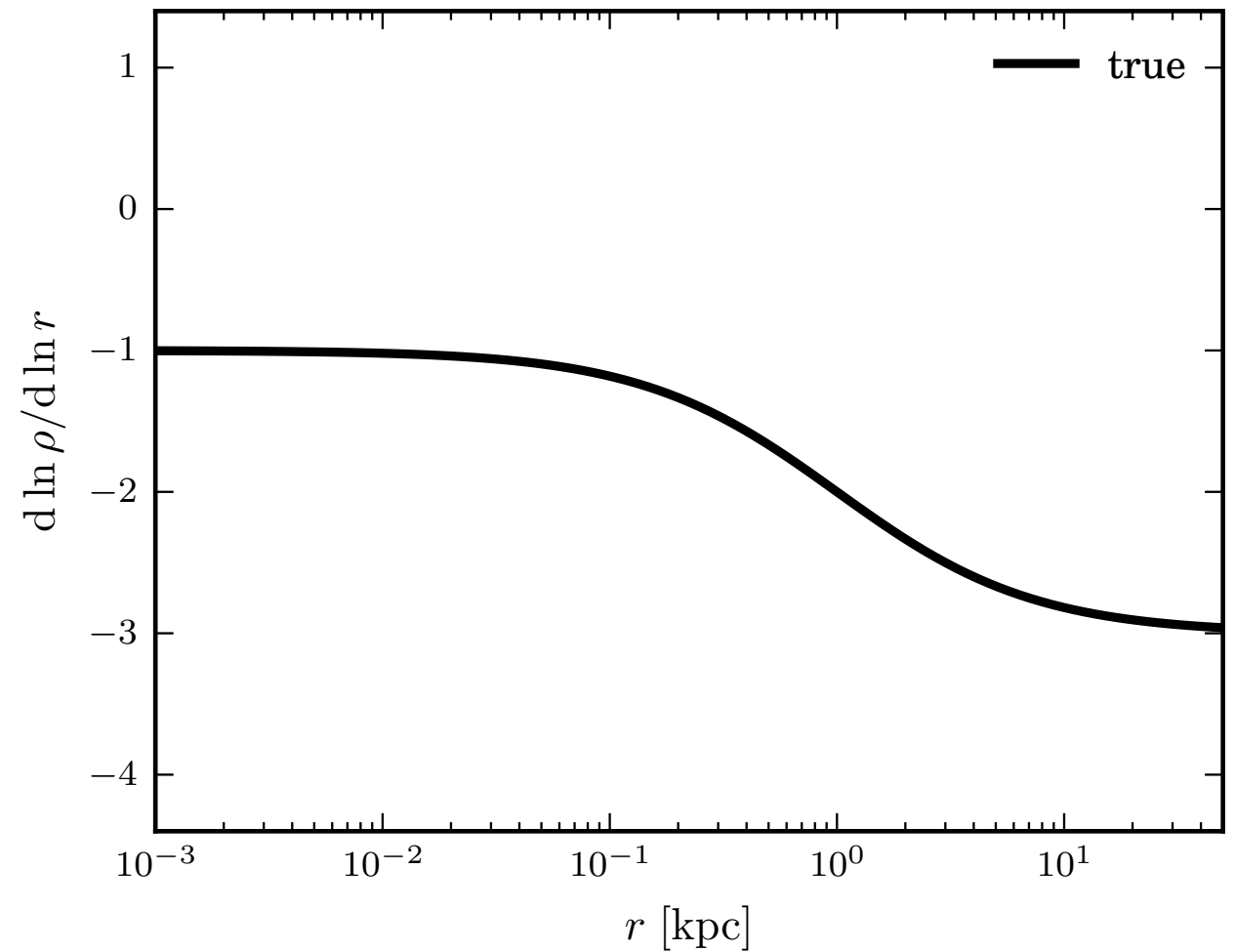
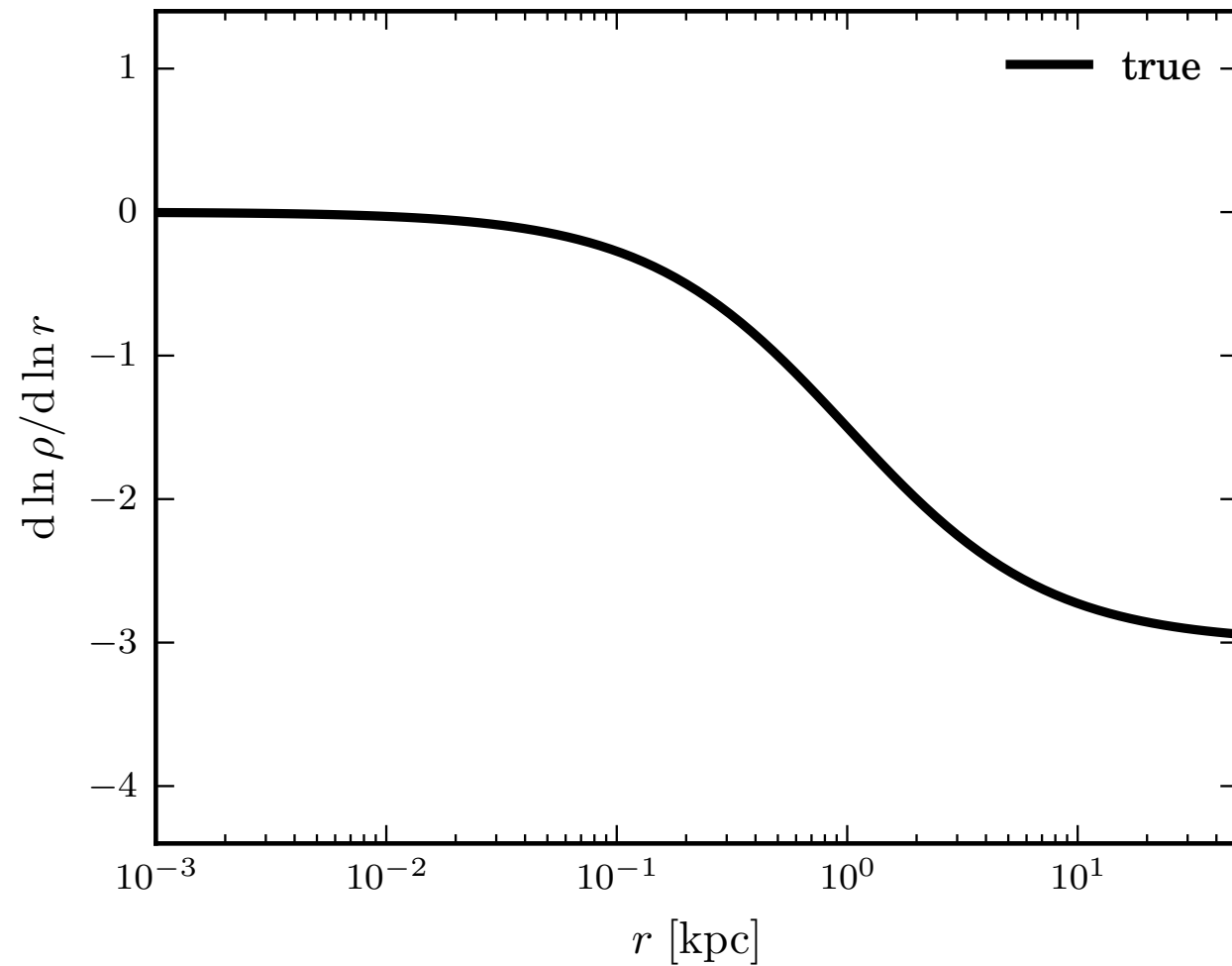
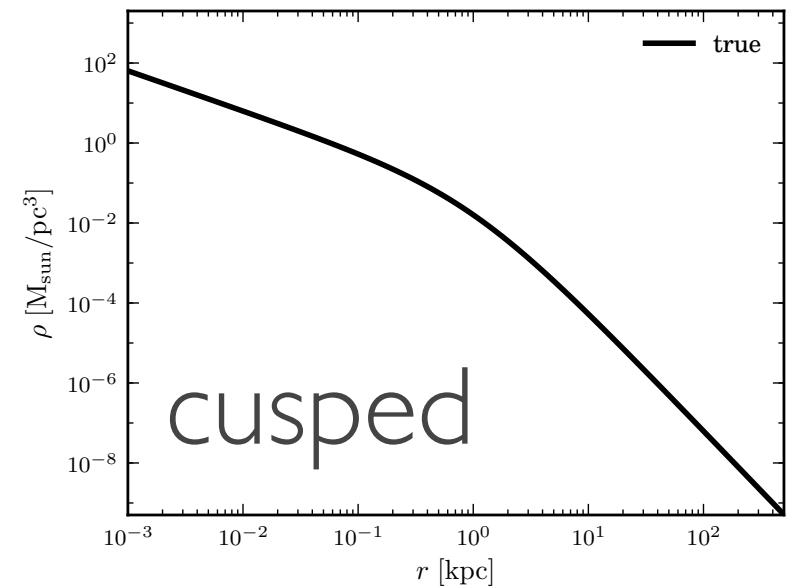
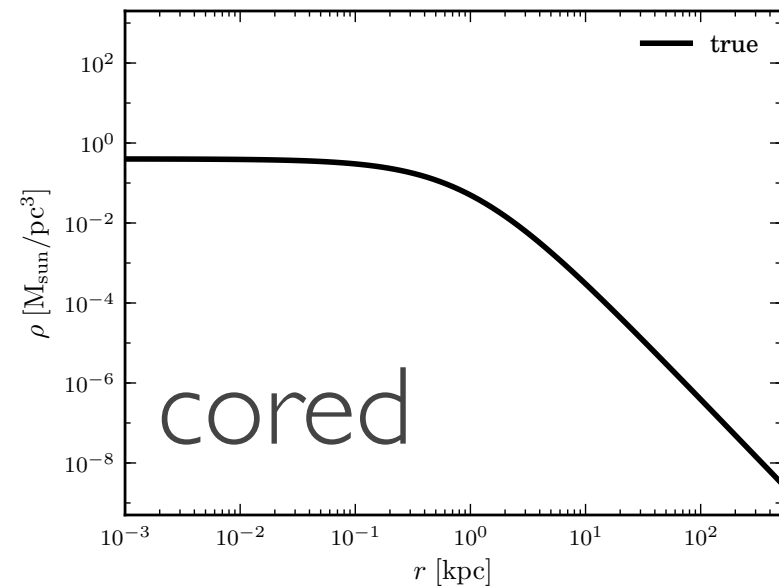


different modelling
approaches

dark matter density slopes

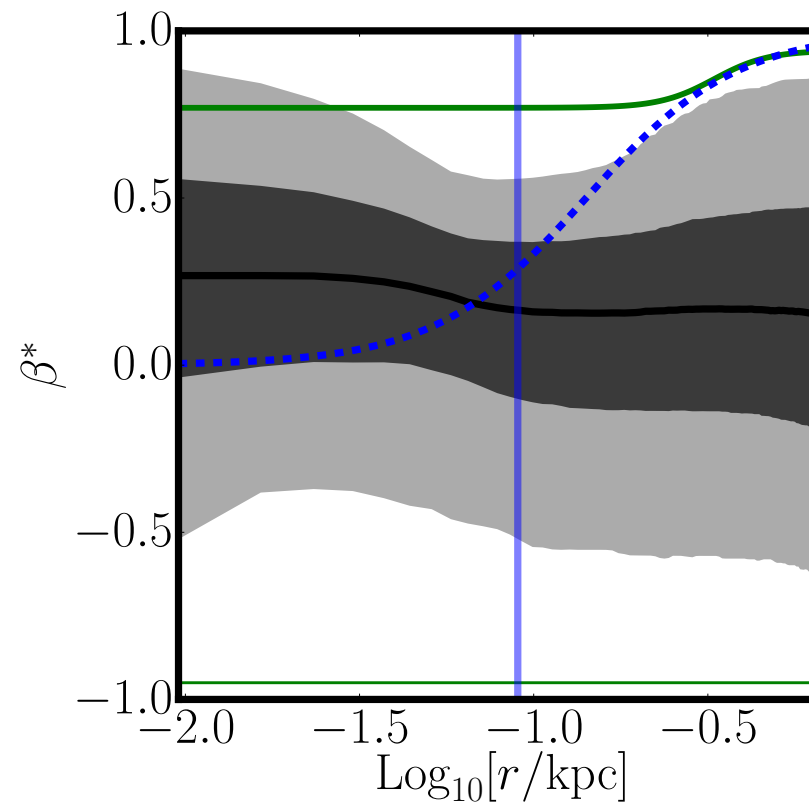
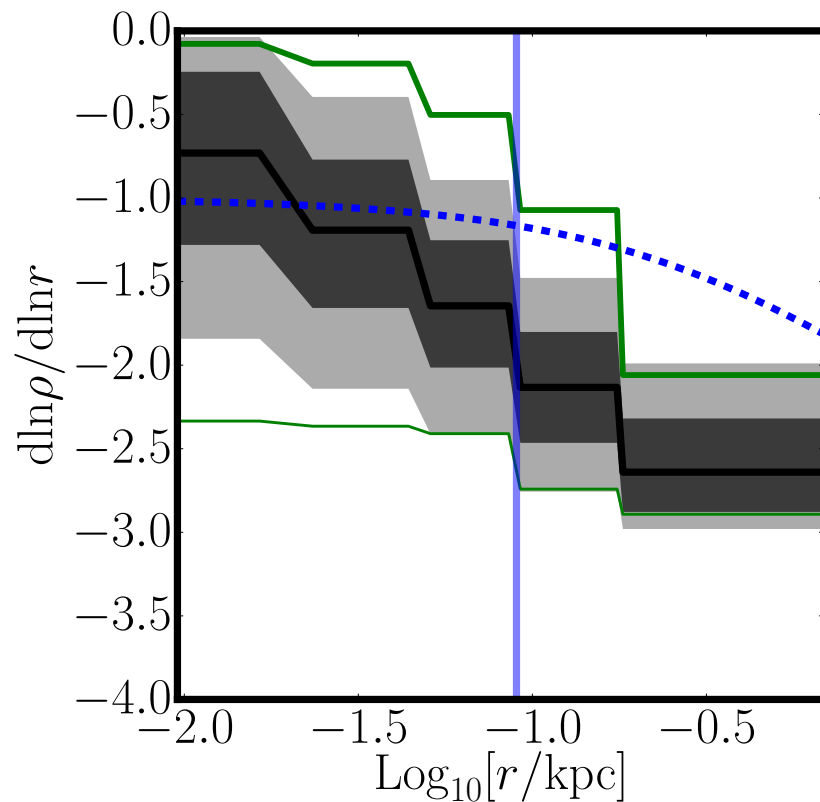


dark matter density slopes

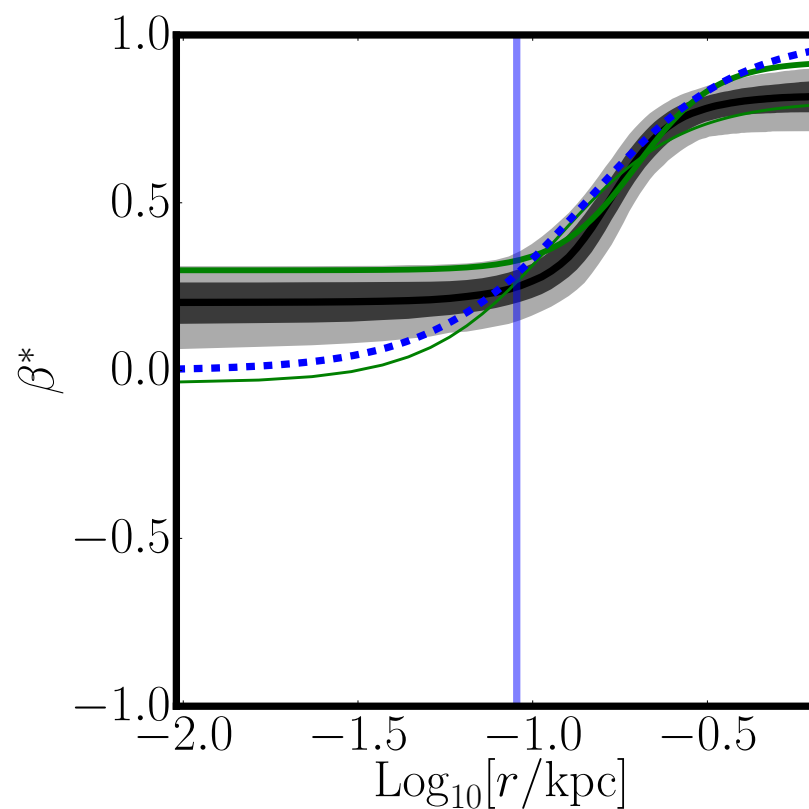
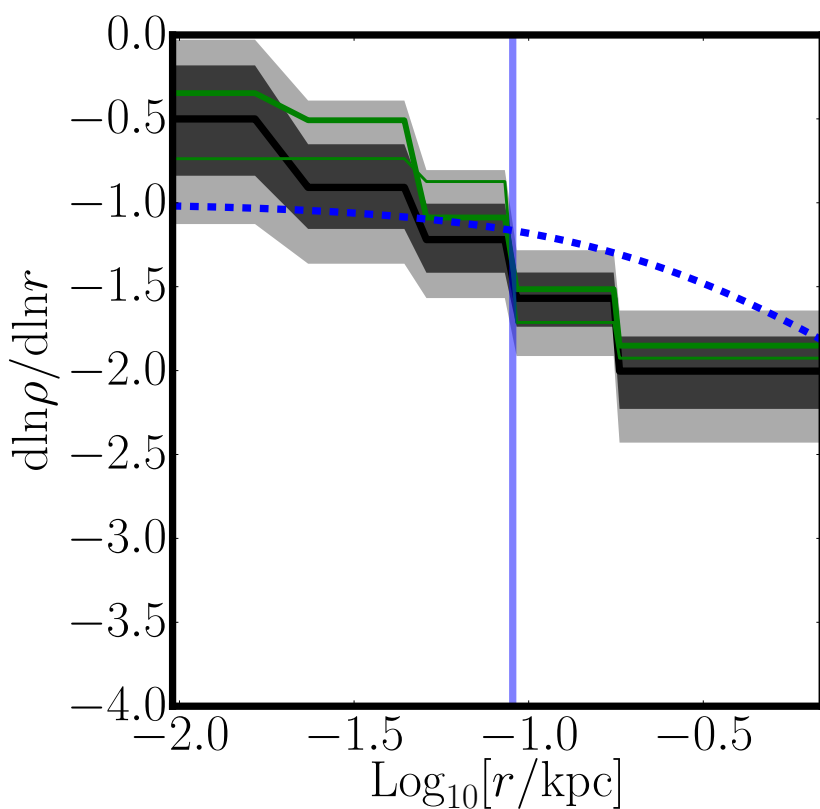


Justin's binned non-parametric fits

1000
non
cusp
OM



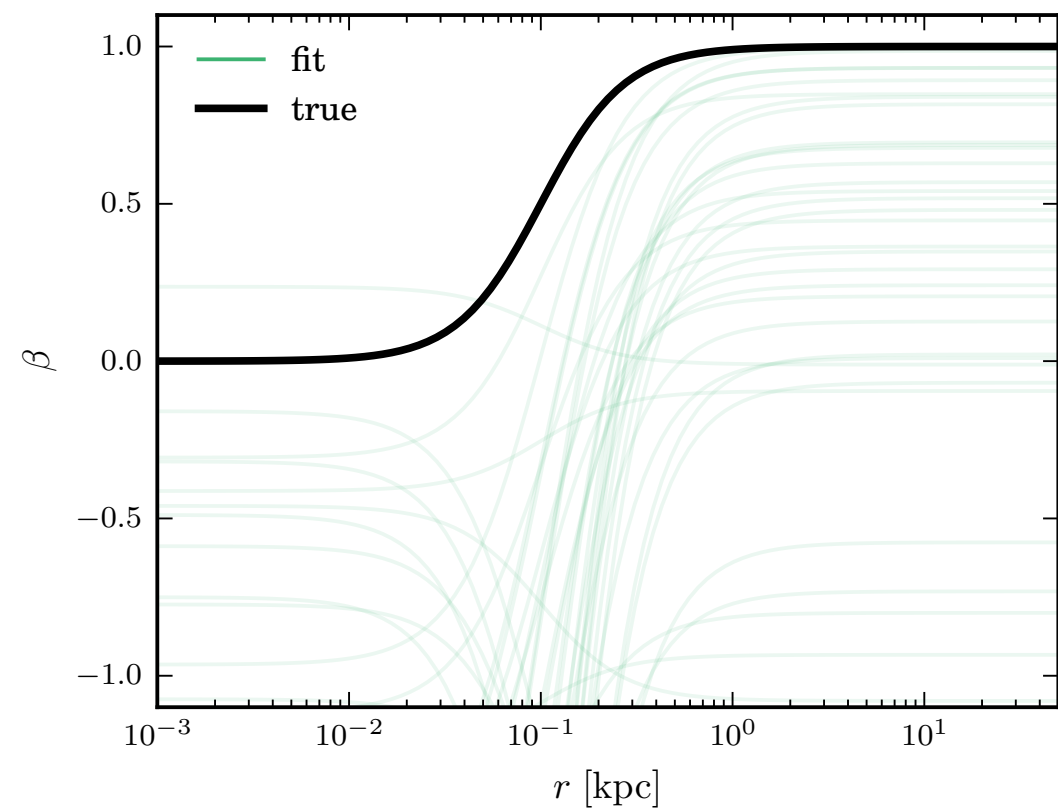
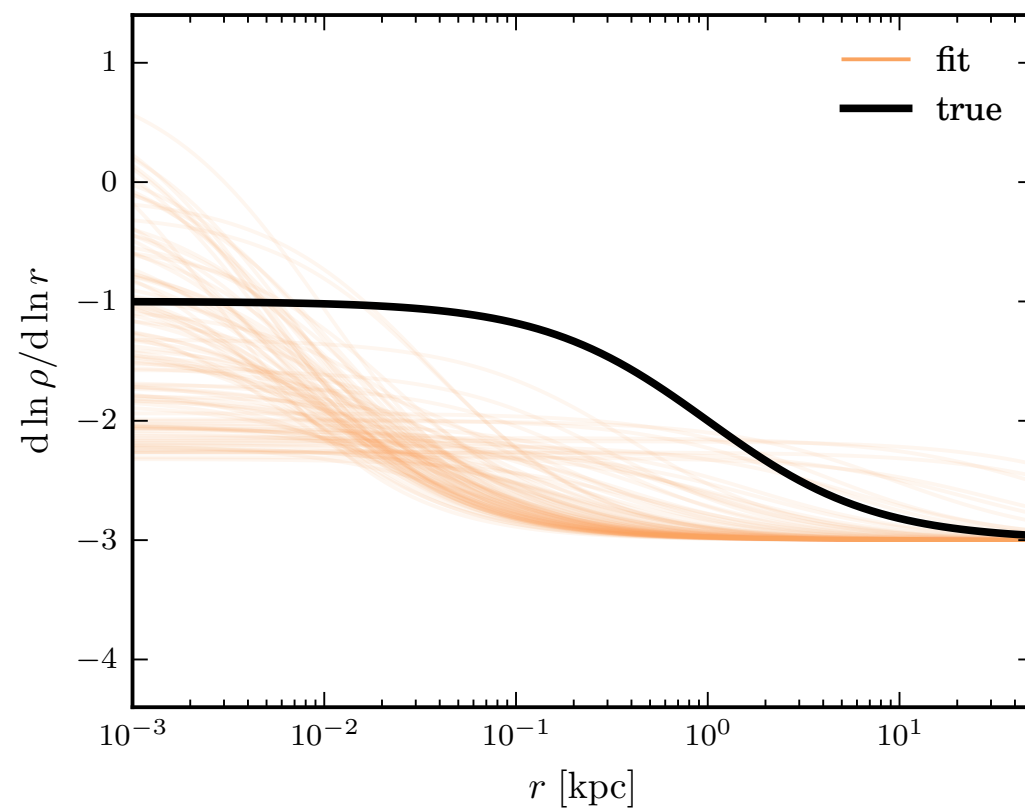
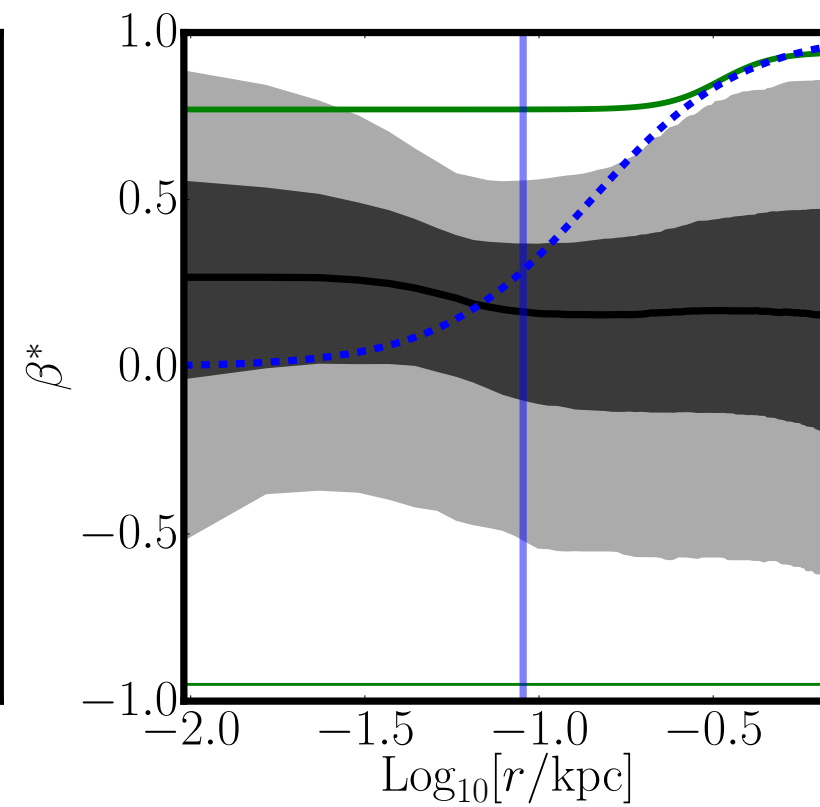
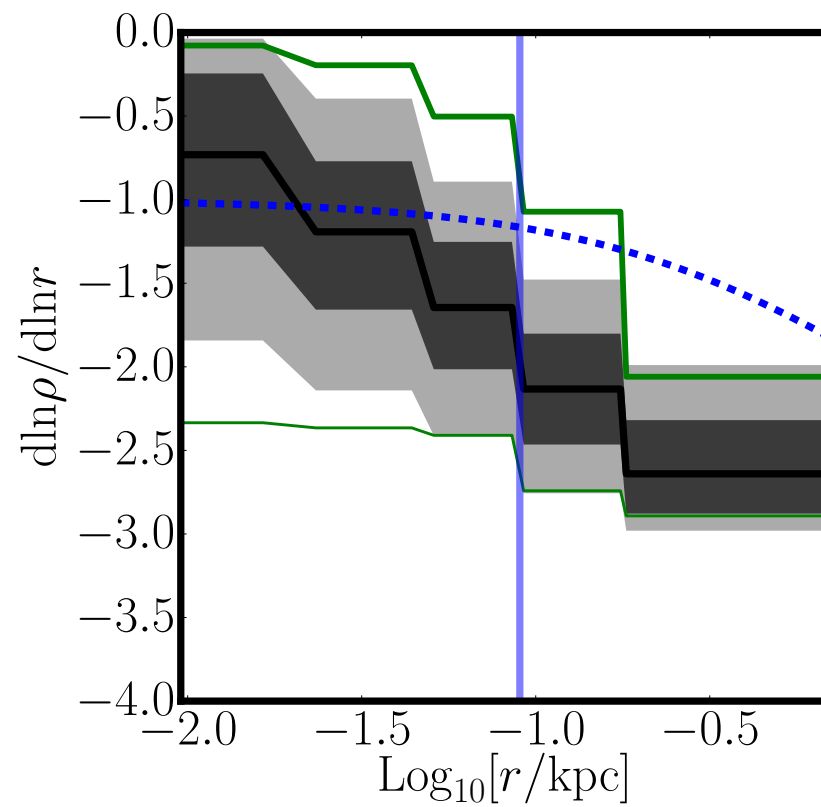
LOS only



LOS + PM

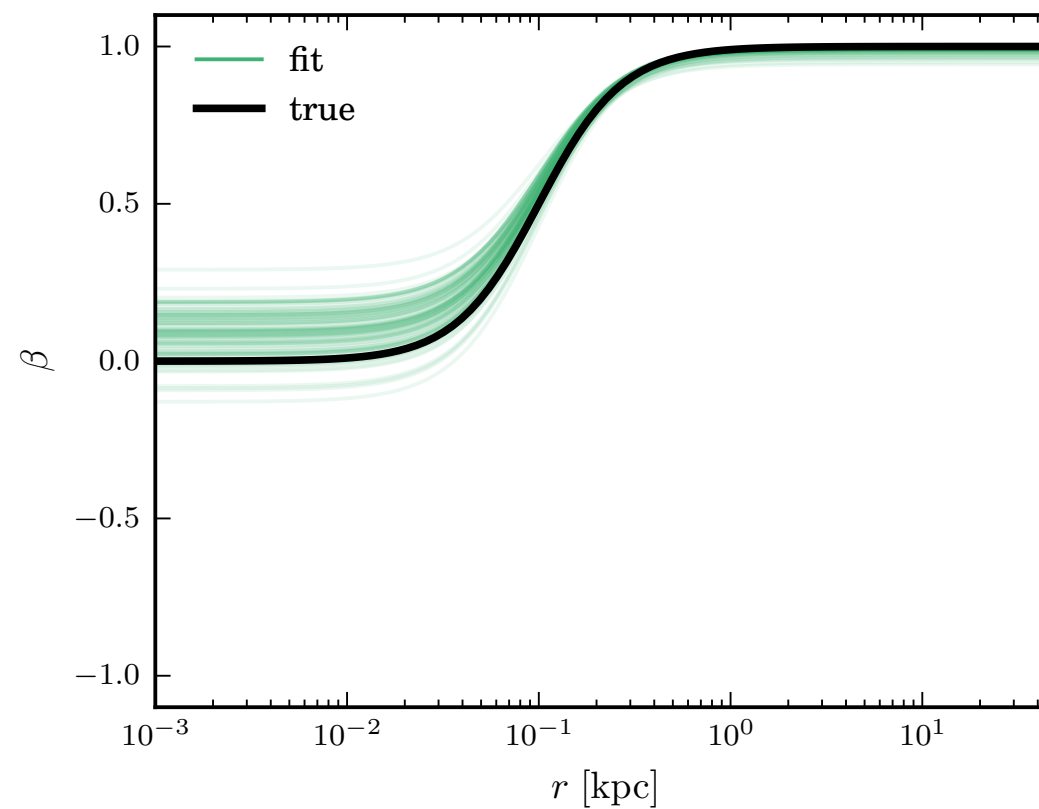
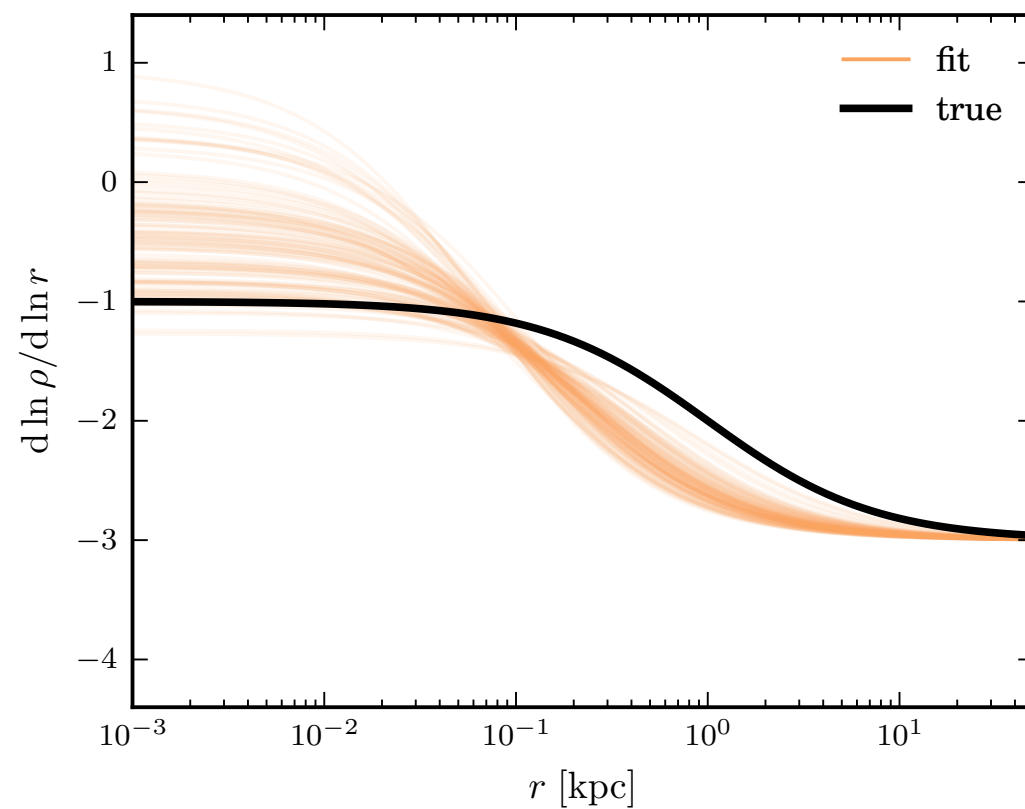
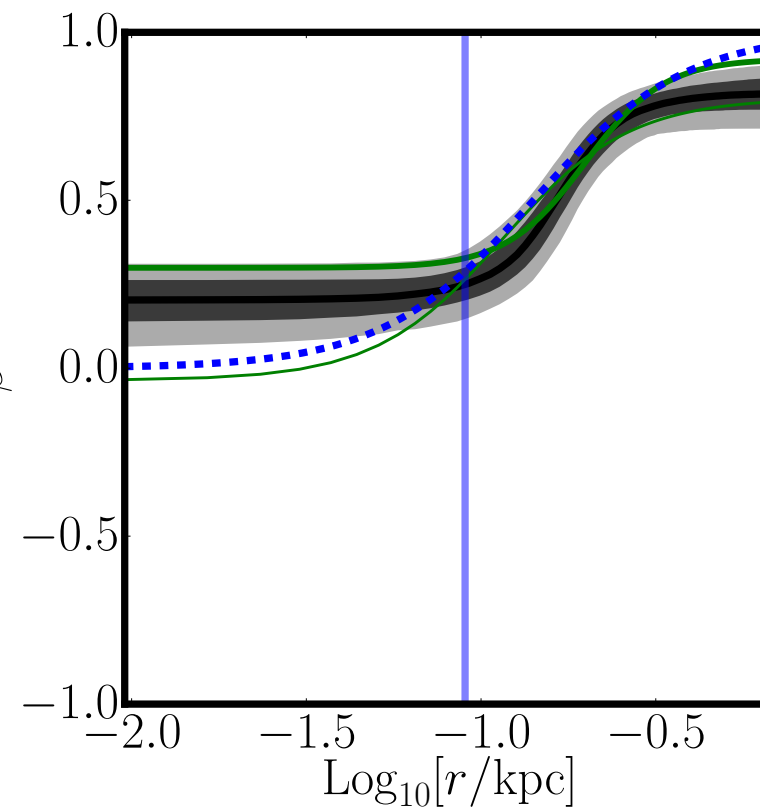
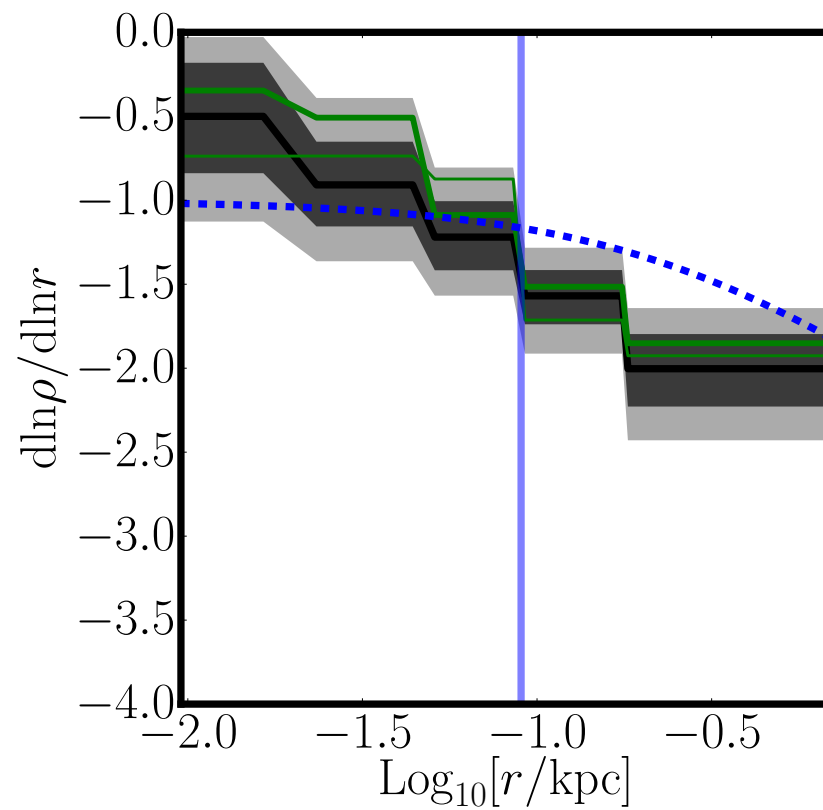
comparison: LOS only

1000
non
cusp
OM



comparison: LOS+PM

1000
non
cusp
OM



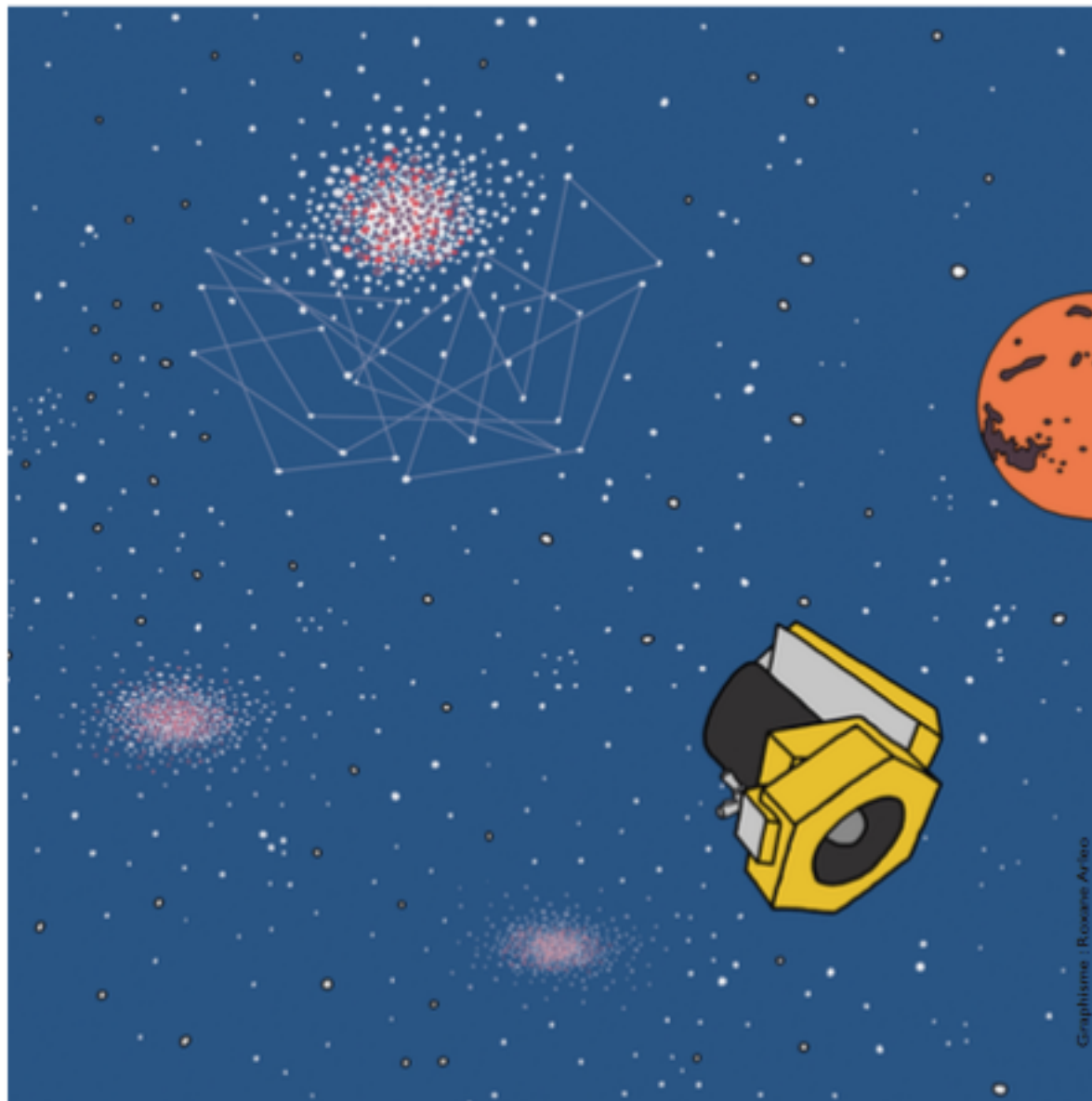
applications

Theia: Gaia 2.0



THEIA

Microarcsecond Astrometric Observatory



Faint objects in motion : the new astrometry frontier

- ◆ medium ESA space mission
- ◆ proposal submitted 5 October
- ◆ PI Celine Boehm
- ◆ Co-PI Alberto Krone-Martins
- ◆ Three science goals:
 - ◆ **Dark matter**
 - ◆ Exoplanets
 - ◆ Neutron stars and black holes
- ◆ used Gaia Challenge work to help define DM science case

Proper motions
will help distinguish between
cores and **cusps**.

