Gaia Challenge - Triaxial Data

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The purpose of these models is to facilitate the testing of mass modelling algorithms on non-spherical stellar systems. It is valuable to know how a particular algorithm will perform when presented with observed data which do not satisfy the underlying symmetry assumptions of the algorithm. The data for this test were generated using the Made-to-Measure (M2M) N-body code from Dehnen (2009, MNRAS, 395, 1079).

This test consists of two models in which the same stellar distribution resides within one of two dark matter haloes, one cusped (StarsInCusp) and one cored (StarsInCore). The halo radial mass density profiles are (α, β, γ) models of the form

$$\rho(r) = \frac{\rho_\mathrm{s}}{\left(\frac{r}{r_\mathrm{s}}\right)^{\gamma}\left(1+\left(\frac{r}{r_\mathrm{s}}\right)^{1/\alpha}\right)^{\alpha(\beta-\gamma)}} \tag{1}$$

The parameter values are given in Table 1. The cusped halo has an inner logarithmic slope of -1 while the cored halo has an inner log slope of -0.23, the same as that of the light distribution. The axis ratios for the halo were b/a = 0.8 and c/a = 0.6.

Table 1: Dark matter halo parameters

Parameter	Cusped Model	Cored Model
α	1	1
β	4	4
γ	1	0.23
r_s (kpc)	1.5	1.5
ρ_s ($\mathrm{M}_\odot$ kpc^{-3})	5.522×10^7	1.177×10^8
M_tot ($\mathrm{M}_\odot$)	1.171×10^9	1.802×10^9

The stellar distribution is also an (α, β, γ) profile, with parameters given in Table 2. The principal axes of the stellar distribution were the same as for the halo, and were assumed to have the same axis ratios. The stars have negligible mass relative to that of the dark matter halo.

Table 2: Parameters of the stellar distribution

Parameter	Stellar distribution
α	0.34
β	5.92
γ	0.23
$r_{\rm s}$ (kpc)	0.81

The velocity anisotropy for the stars $\beta(r)$ as a function of radius is given by

$$\beta(r) = \frac{r_{\rm s,\beta}^{\eta}\beta_0 + r^{\eta}\beta_{\infty}}{r^{\eta} + r_{\rm s,\beta}^{\eta}} \tag{2}$$

where $r_{\rm s,\beta} = 0.81$ kpc, $\beta_0 = 0$, $\beta_\infty = 0.5$ and $\eta = 0.5$. The stellar velocity distribution is thus isotropic at small radii and becomes radially anisotropic at large radii ($r \gtrsim 0.81$ kpc).

The data files consist of the full 3D positions and velocities for the (single) stellar component in each model as well as projected data for 4 distinct viewing directions - along each of the principal axes and along an intermediate axis at 45 degrees to the principal axes. Velocity errors of 2km/s have been added to the line of sight velocities - however, the files also contain the original velocities so that users can add their own velocity errors if required. The surface density profile for the stars when viewed along each projection axis are also provided. These profiles were obtained using the full set of 200K stars in order to minimise numerical noise.