falPot. GalaxyPotential generating code

This documentation is just here as a basic guide to explain how to use falPot. See Section 2.3 of Dehnen & Binney (1998) for a fuller explanation of how it works.

falPot generates the potential due to a sum of axisymmetric disks and spheroids. It's basic functions are probably best understood by looking at the executable provided – testfalPot.

N.B. In all cases here, the length unit is kpc, the time unit is Myr, and the mass unit is $M_\odot$. For reference, $G = 4.49866 \times 10^{-12}\mathrm{kpc}^3\mathrm{Myr}^{-2}M_\odot^{-1}$. A velocity of 1 kpc Myr^{-1} = 977.77km s^{-1} (See Units.h for further).

1 Input

The file that is given as the input file for the potential must be of the following form:

3						# No. Disks ($0 \leq$ No.disks ≤ 3)
8.90e7	1.8	0.04	0	0		# Param. for each of the three disks.
3.50e7	1.2	-0.15	0	0		# **N.B** *essential* to give 5 param.
1.30e7	1.1	0.25	0	0		# No. lines of param. = No. disks
2						# No. Spheroids ($0 \leq$ No.sph. ≤ 2)
4.0e7	0.8	-0.5	1.4	10	50	#
2.0e7	0.2	-1.5	3.4	10	50	# *essential* to give 6 parameters

1.1 Disk

The disk parameters, as given in that file are (in order) Σ_0, R_d, z_d, R_0, ϵ.

Σ_0 is the disk's central surface density (in $M_\odot\mathrm{kpc}^{-2}$ and the absence of a cutoff), R_d is the disk scale radius, z_d its scale height (though note there is a difference between negative and positive values), and R_0 is an inner cutoff radius (all in kpc). The term ϵ can provide a small perturbation to the surface density. In numerical terms (cylindrical polars), these give a surface density

$$\Sigma(R) = \Sigma_0 \exp\left(-\frac{R_0}{R} - \frac{R}{R_d} + \epsilon\cos\left(\frac{R}{R_d}\right)\right), \tag{1}$$

i.e. a standard exponential disk with optional hole in the middle and/or ϵ term modulation.

The vertical structure of the density is either an exponential in $|z|$ (if $z_d > 0$), or isothermal (if $z_d < 0$), i.e.

$$\rho_d(R,z) = \begin{cases} \frac{\Sigma(R)}{2z_d} \exp\left(\frac{-|z|}{z_d}\right) & \text{for } z_d > 0 \\ \frac{\Sigma(R)}{4(-z_d)} \operatorname{sech}^2\left(\frac{z}{2\,z_d}\right) & \text{for } z_d < 0. \end{cases} \tag{2}$$

N.B. There is a factor of two in the denominator of the sech^2 profile. That is so that they tend to the same thing as $z \to \infty$.

1.2 Spheroids

The spheroid parameters are (in order) ρ_0, q, γ, β, r_0, r_{cut}.

ρ_0 is a scale density (in $\mathrm{M}_\odot \mathrm{kpc}^{-3}$; q is the axis ratio ($q < 1$ is oblate, $q > 1$ is prolate); γ is the inner density slope, β the outer density slope; r_0 is a scale radius and r_{cut} is a cutoff radius (both in kpc). This corresponds to a density profile

$$\rho_s = \frac{\rho_0}{(r'/r_0)^\gamma (1 + r'/r_0)^{\beta-\gamma}} \exp\left[-\left(r'/r_{cut}\right)^2\right], \tag{3}$$

where, in cylindrical coordinates

$$r' = \sqrt{R^2 + (z/q)^2} \tag{4}$$

References

Dehnen W., Binney J., 1998, MNRAS, 294, 429