ANALYSING OBSERVATIONS USING ORBITAL TORUS MODELS

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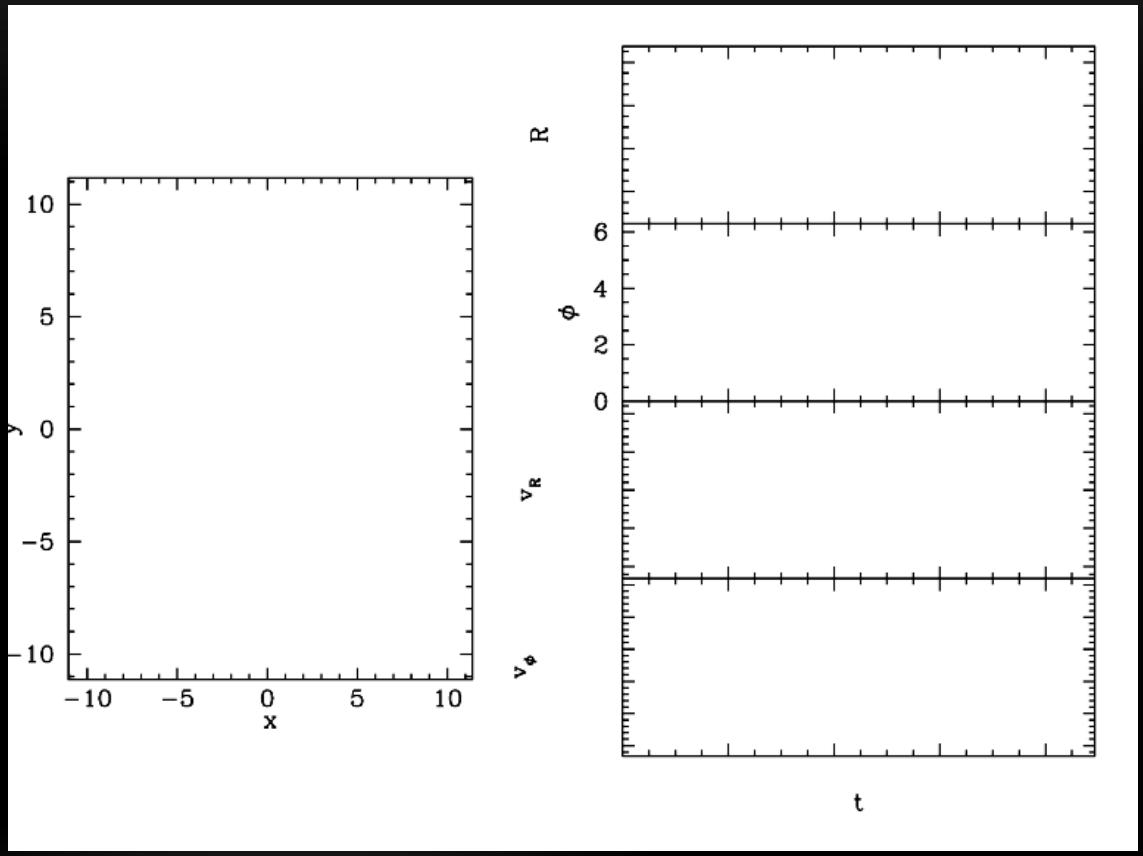
ANGLE-ACTION COORDINATES

Orbits in galactic potentials are messy

Normally stored as time-series.

Better to work in coordinates in which the orbits are simple…



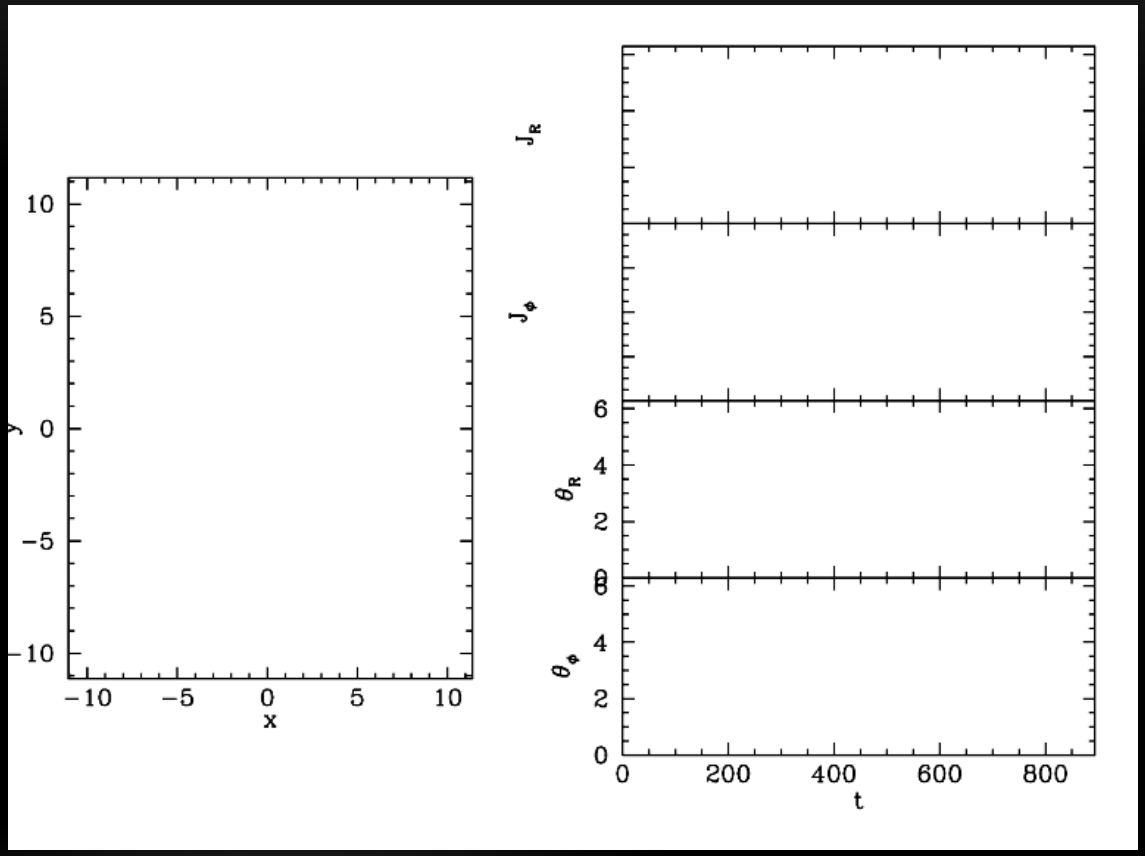
ANGLE-ACTION COORDINATES

Actions (***J***) are constant (define/label an orbit)

Distribution function f(***J***) is in equilibrium

Angles (***θ***) increase linearly with time (2π-periodic)

Analytic for very few potentials, but available numerically through 'torus' method. (Specialist software)



MODELLING

- Need to start from assumption of steady state i.e. f(J)
- [Really we need $f_\lambda(\boldsymbol{J})$ for each population λ, so f(J,age,Fe/H,…)]
- Can make a lot of progress using simple form

$$f(\mathbf{J}) \propto \prod_i \exp\left(-\frac{\omega_i J_i}{\sigma_i^2}\right)$$

MODELLING

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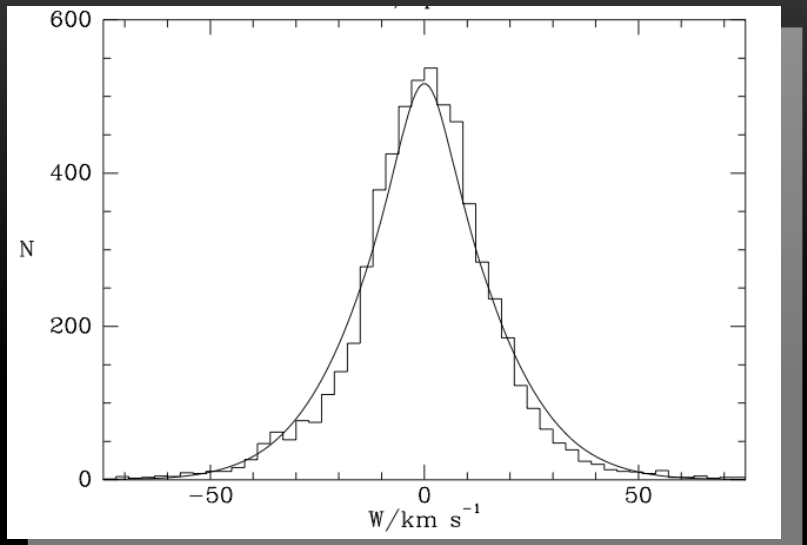
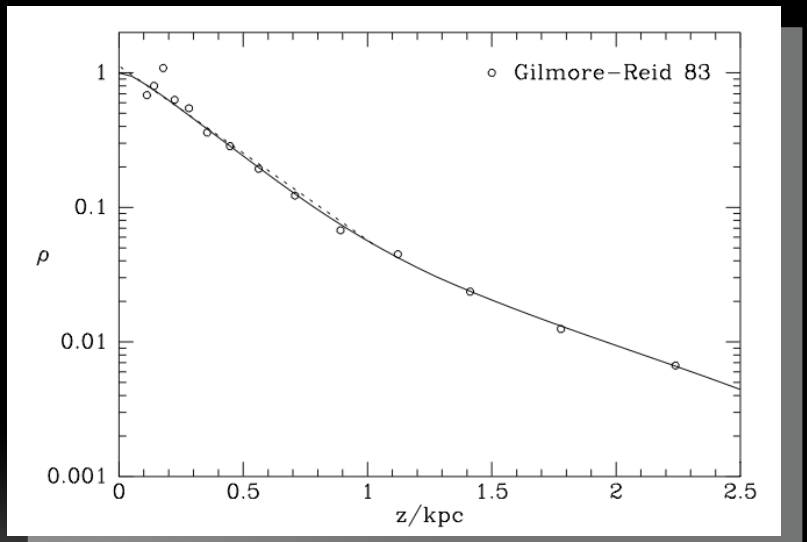
Binney (2010) showed that this df can provide simultaneous fits to local v_z distribution and vertical structure





MODELLING

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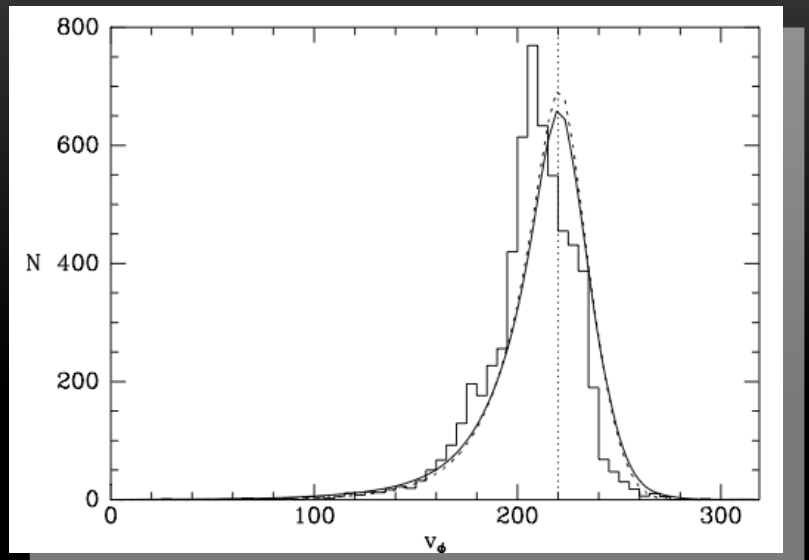
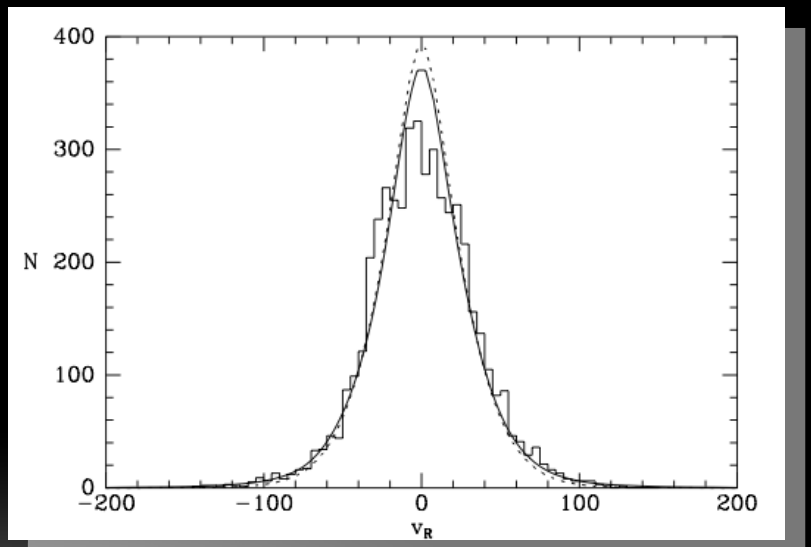
Binney (2010) showed that this df can provide simultaneous fits to local v_z distribution and vertical structure

And velocity distribution in the plane



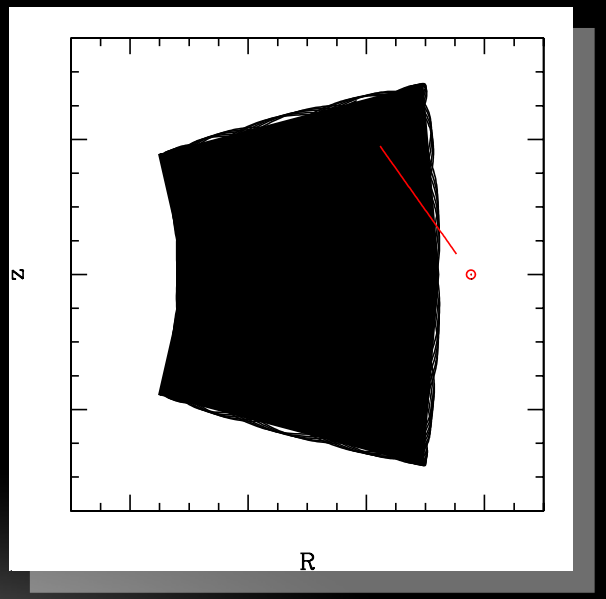


CONVERTING TO OBSERVABLE SPACE

- Can't bin in observable space – too many dimensions (c.f. Binney's talk)
- Need a direct way of going from model to prob. density P(observables), integrate LOS.
- Torus models ideal. Sample in J.

For each J (i.e. each orbit):

- Orbit integration gives you limited set of points along LOS
- Torus gives you all information about LOS (dynamics) and can 'paint' with other properties (colour, chemistry, etc) and determine selection prob.



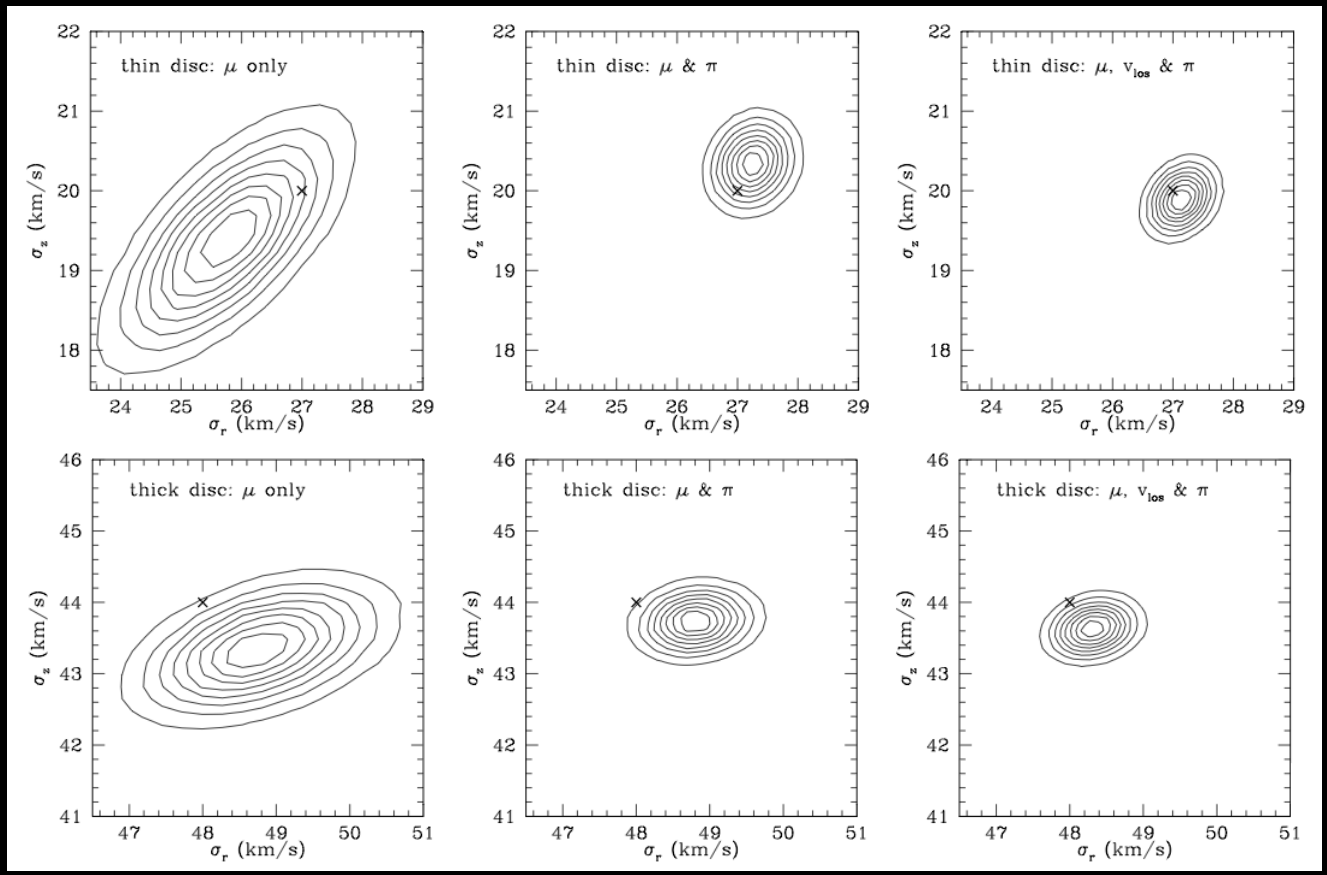
TESTS WITH PSEUDO-DATA

How well can we recover known f(J) from minimal observational data?

With 10000 stars, simple (magnitude) limits and (Gaia-ish) data sets of varying richness

(McMillan & Binney, 2012)

Potentially provides info on ideal N vs accuracy for surveys



Dynamical Catalogue – ongoing work

Currently working on an extension of the basic pseudo-data

Intention is to release this model to the community as a catalogue with particle phase-space coordinates, actions, and stellar ages (allowing stars to be painted according to preferred chemical evolution etc. models)

Happy to hear suggestions as to what the community wants to see