Why models based on actions?

- Jeans theorem encapsulates loss of freedom on restriction to equilibrium: f(x,v) ! f(I_1, I_2, I_3)
- Actions are uniquely favoured integrals:
  - Adiabatic invariants
    - Useful during slow changes in ©
    - Enable us to identify orbits in neighbouring potentials
  - Easy to understand physically
    - Stellar population is a distribution of stars in 3d action space
    - range (0,1)
  - Can be used as momenta of a canonical coordinate system
    - conjugate variables the angles µ
  - (µ,J) the natural coordinates of perturbation theory
  - $d^3x\ d^3v=(2¼)^3\ d^3J$ so f(J) density of stars in 3d action space
  - Several ways to compute them (in addition to torus machine)
    - Adiabatic approx (B & Schoenrich)
    - Staeckel approximations (Sanders)
    - Also for N-body orbits (Fox)

Why models with known DF?

- Coordinates of individual stars of no significance
  - it is the density of stars that carries information
- Since stars are distinguishable by age, mass, [Fe/H], [®/Fe],…. we need many DFs f(J)
- On account of selection effects and errors we must fit model in space of observables
  - (l,b,ϖ, ¹$_{®}$, ¹$_{±}$, v_{los}, V, V-I, T_{eff}, logg, [Fe/H],…)
  - 11d and counting
- n graduations per axis ! n^d cells, >30 stars/cell ! 1.5e9 stars in catalogue
- Even with Gaia barely feasible because getting optimal grid will be extremely hard
- But suppose have N-body model
  - Great majority of particles will be too far from Sun enter mock catalogue, so need >>10^9 particles to get Gaia-sized catalogue
- People usually project catalogue to low-d subspace and grid that
  - Projection erases correlations between variables but correlations are key