SNAPDRAGONS tutorial
Gaia Challenge III

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Hunt & Kawata (2015), MNRAS, 450, 2132

SNAPDRAGONS

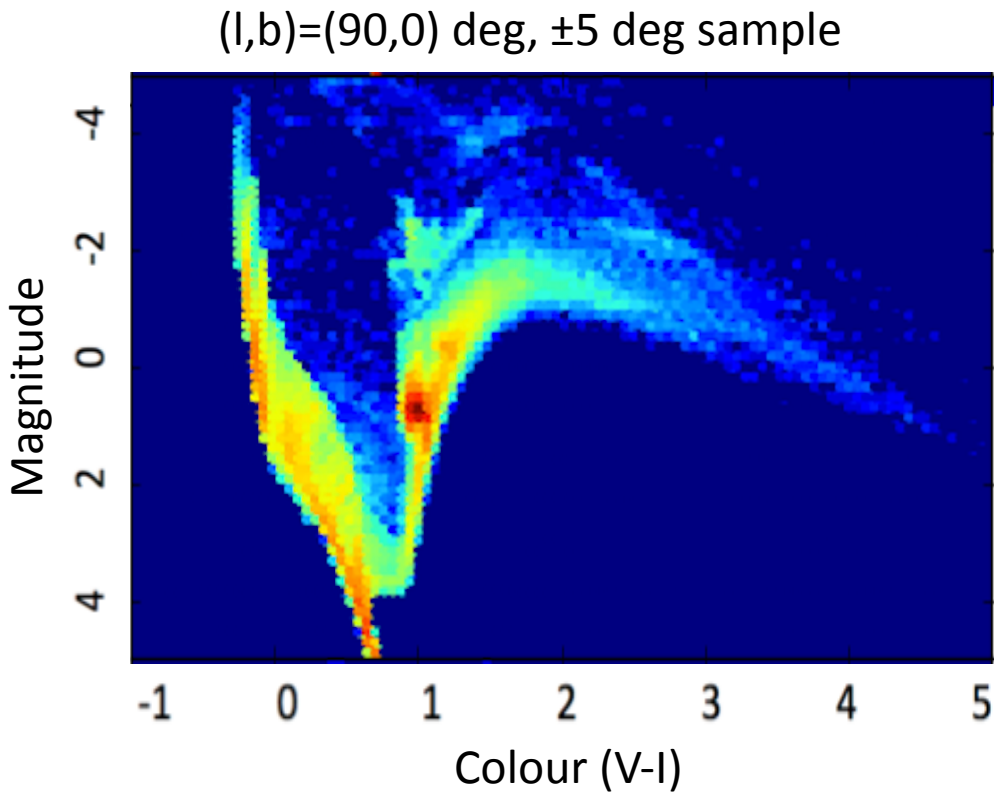
- Generates stars from *N*-body particles (Hunt et al. 2015, MNRAS, 450, 2132)

- Adds extinction (from Galaxia maps) and Gaia error (from Merce Romero-Gomez).

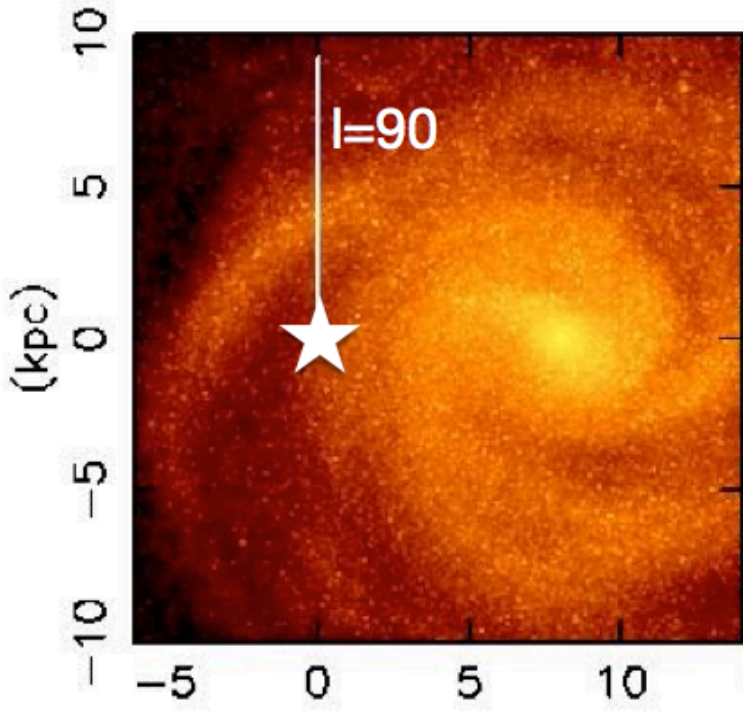
- No smoothing: clear particle <-> star relation.

SNAPDRAGONS

- Synthetic CMD has mix of stellar types.
- Makes mock Gaia stellar data.
- Can be used to test models/theories.

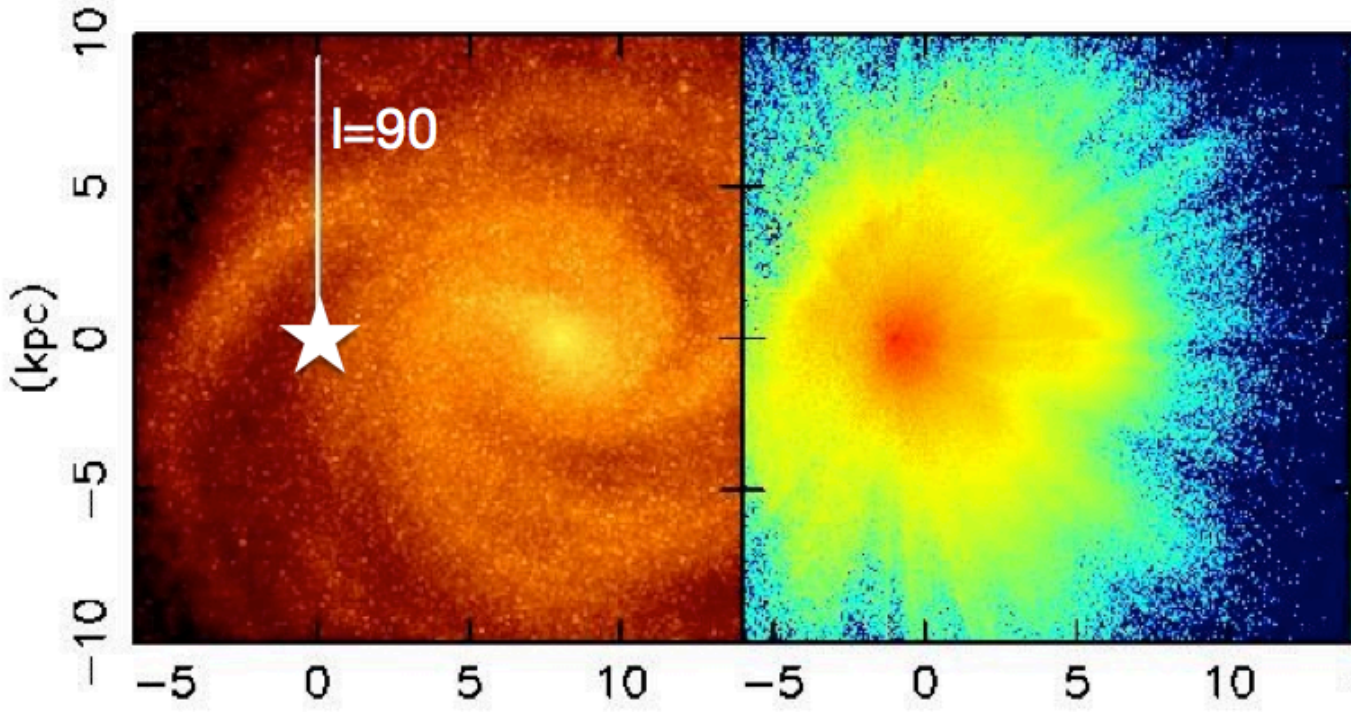


SNAPDRAGONS mock data



N-body simulation
with co-rotating spirals
(Kawata et al. 2014)

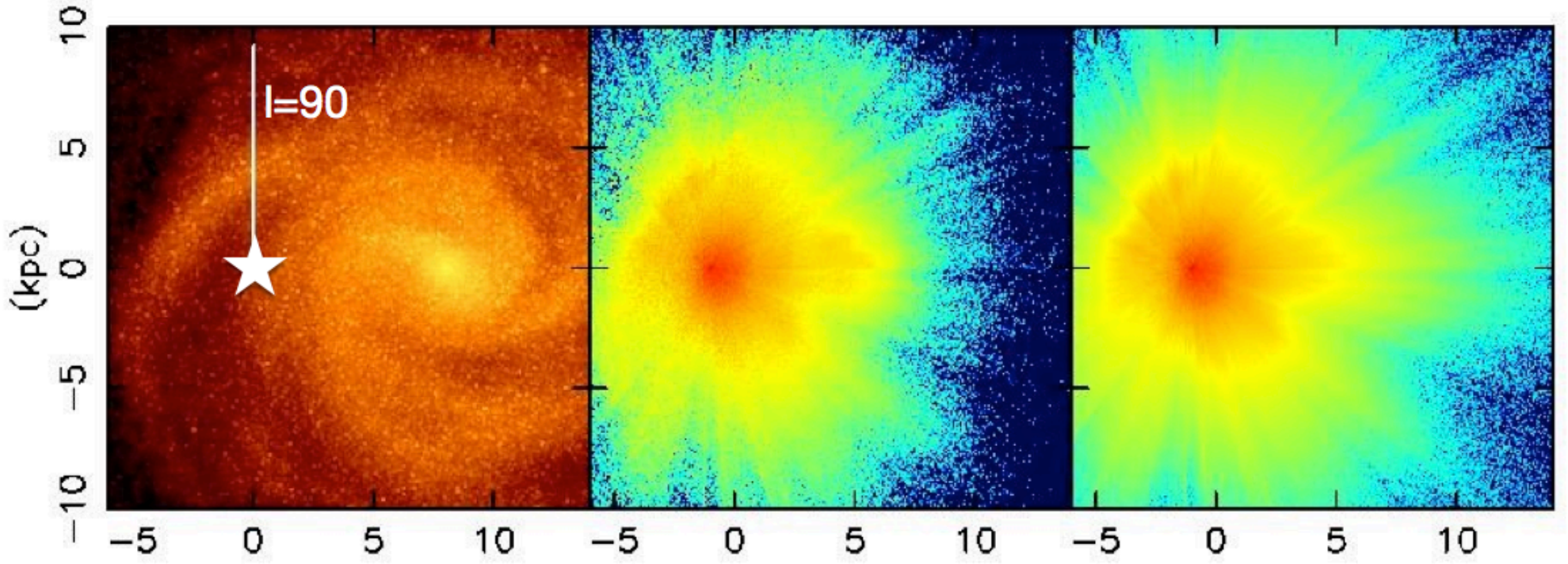
SNAPDRAGONS mock data



N-body simulation
with co-rotating spirals
(Kawata et al. 2014)

SNAPDRAGONS
V<16 mag stars
with extinction

SNAPDRAGONS mock data



N-body simulation with co-rotating spirals (Kawata et al. 2014)

SNAPDRAGONS V<16 mag stars with extinction

SNAPDRAGONS with extinction and Gaia errors

Inputs / Outputs

- Inputs (*N*-body particles)
  - x, y, z, vx, vy, vz, mass, metallicity, age

- Outputs (Individual stellar data)
  - alpha, delta, parallax, proper motions, radial velocities, magnitude, colour, cartesian pos & vel, l & b . . . Both with and without Gaia errors

Stellar output

- Outputs only visible stars
- Set ‘ChosenLim’ at beginning of PopSynth.F to control minimum brightness to be generated
- This saves on computational time, can still generate large set if desired

```
c *** Minimum magnitude necessary ***
      ChosenLim=16.0d0
      write(6,*) 'Limited to V<16'
```

Other user choices

```
c *** USER OPTIONS ***
c *** Output to binary (1) or ASCII (0)? ***
      Binary=0
c *** Minimum magnitude necessary ***
      ChosenLim=16.0d0
      write(6,*) 'Limited to V<16'
c *** Add Gaia errors? (1=yes) ***
      error=1
c *** Add Milky Way Extinction (1=yes) ***
      EXTINCT=1
c *** Extintion map (1=Schlegel, 0=2d analytic) ***
      Schlegel=1
c *** Choose IMF slope (Currently Salpeter) ***
      xIMF=1.35d0
c *** Random seed ***
      idum=-1314
c *** Set Sun position / velocity ***
      xsun=-0.08d0
      zsun=0.0d0
      vlsr=1.1d0*VUKMS
c *** 1.1d0*VUKMS=228.14 km/s ***
      usun=0.0d0
      vsun=0.0d0
      wsun=0.0d0
c *** END USER OPTIONS ***
```

Output binary or ASCII

Magnitude limit

Add errors?

Add extinction?

Choose IMF slope

Solar position and motion

On the wiki page

SNAPDRAGONS tutorial

Find here the resources for the SNAPDRAGONS tutorial on Wednesday 16:30-17:30

Zipped SNAPDRAGONS source code and example input file snapdragons.tar.gz

Download snapdragons.tar.gz, and extract

You now have the directory Snapdragons/

(Will link from this page to updated version of SNAPDRAGONS when properly hosted)

Compilation / run

- Requires gfortran

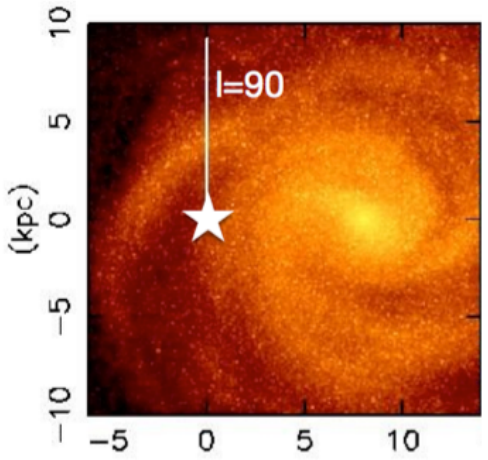
- Compile within the directory Snapdragons/ type:

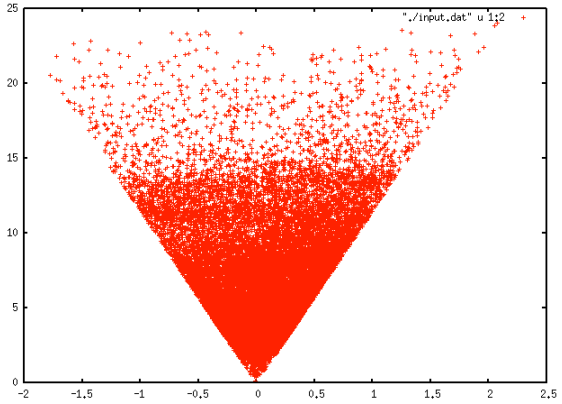
gfortran PopSynth.F Gaia-errors.F -o Snapdragons

- Then run ./Snapdragons

Example

- From Hunt & Kawata (2015), MNRAS, 450, 2132
- Using Snapdragons/ini/input.dat example file
- This is a cone selection of radius 5 degrees around l=90, b=0 (galactic plane, in the direction of rotation)





Example: run

```
jash2@msslhz-2:~/work/Snapdragons$ Snapdragons
 Limited to V<16
 Reading Extinction arrays
 Schlegel extinction array Read
 3D factor array Read
 Extinction running
 Isochrones Read
 Not using correction from Sharma et al. (2014)
  reading gfactor-Jun2013
 100 % complete
 You generated   408955.90310528583      solar masses of stars!
 You needed   409357.44829007459      solar masses of stars!
 You have   401.54518478875980      deficit
 You generated      233386  stars      141066  selected
```

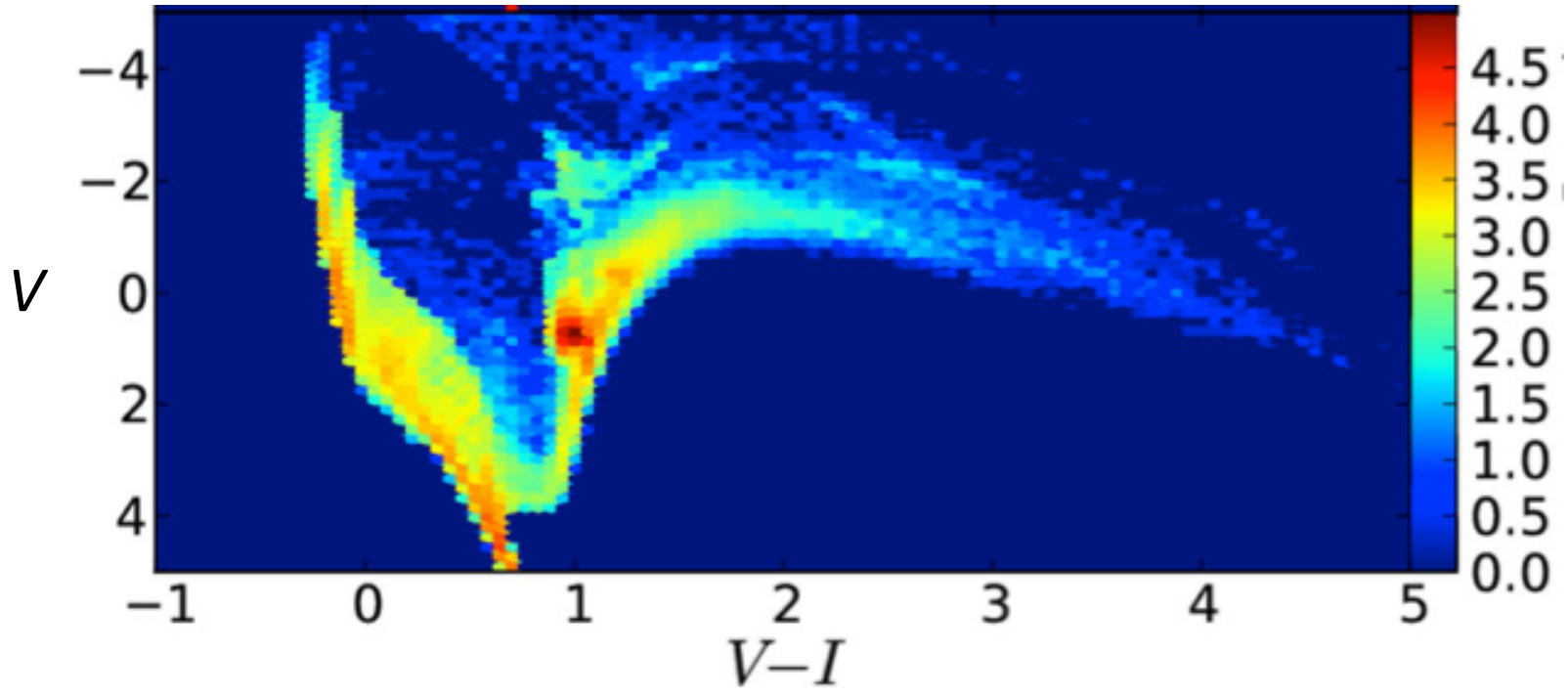
Example: output

Once SNAPDRAGONS has run, you'll have output/GeneratedStars.dat

1 alpha (radians)
2 delta (radians)
3 pi (arc seconds)
4 mu alpha (mas per year)
5 mu delta (mas per year)
6 radial velocity (km/s)
7 observed alpha
8 observed delta
9 observed pi
10 observed mu alpha
11 observed mu delta
12 observed vr
13 alpha Gaia standard deviation
14 delta Gaia standard deviation
15 pi Gaia standard deviation
16 mua Gaia standard deviation
17 mud Gaia standard deviation
18 vr Gaia standard deviation
19 G Magnitude (mag)
20 G_bp - G_rp (mag)
21 observed G Magnitude (mag)
22 observed G_bp - G_rp (mag)
23 G Magnitude Gaia standard deviation (mag)
24 G_bp - G_rp Gaia standard deviation (mag)
25 observed V (magnitude)
26 true distance from sun (kpc)
27 x (kpc)
28 y (kpc)
29 z (kpc)
30 vx (km/s)
31 vy (km/s)
32 vz (km/s)
33 mass (solar mass)
34 GRVS
35 observed V-I
36 extinction
37 V no-ex
38 V-i no-ex
39 metallicity*10^6 (z metallicity not Fe/H)
40 Age (log10years)
41 observed distance (kpc)
42 observed x (kpc)
43 observed y (kpc)
44 observed z (kpc)
45 observed vx (km/s)
46 observed vy (km/s)
47 observed vz (km/s)
48 observed vr
49 observed vrot
50 rp
51 vr
52 vrot
53 orp
54 mu alpha (km/s)
55 mu delta (km/s)
56 observed mu alpha (km/s)
57 observed mu delta (km/s)
58 v_l
59 v_b
60 observed v_l
61 observed v_b
62 l
63 b

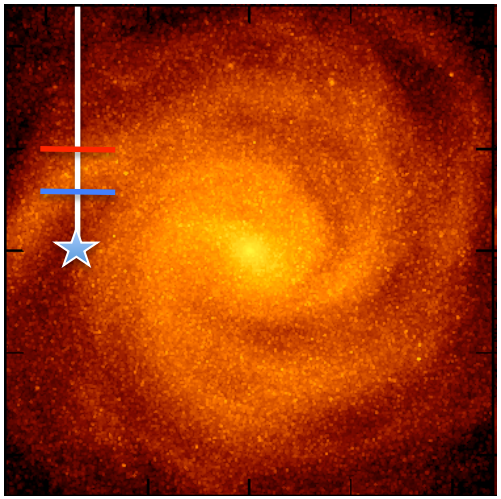
Example: CMD

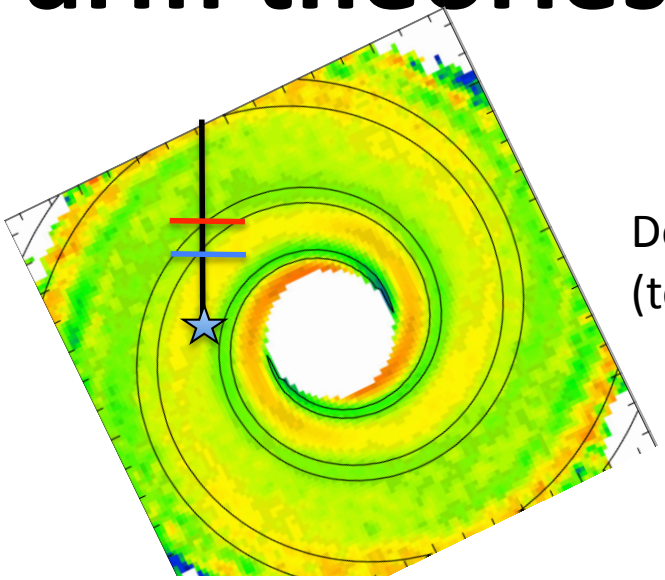
Running SNPADRAGONS on this input file gives the following CMD



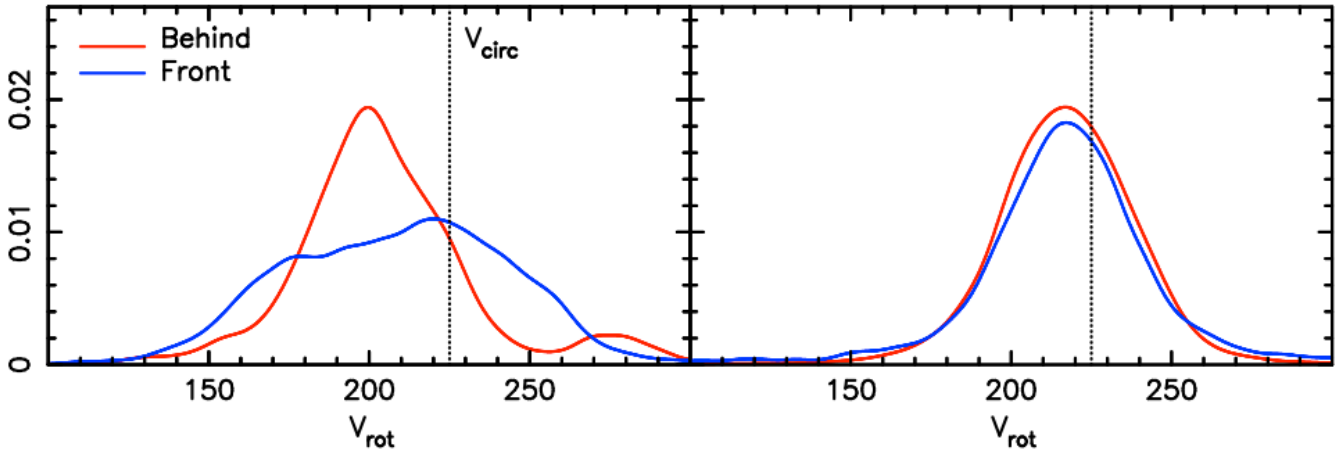
Testing spiral arm theories

Co-rotating
(*N*-body)



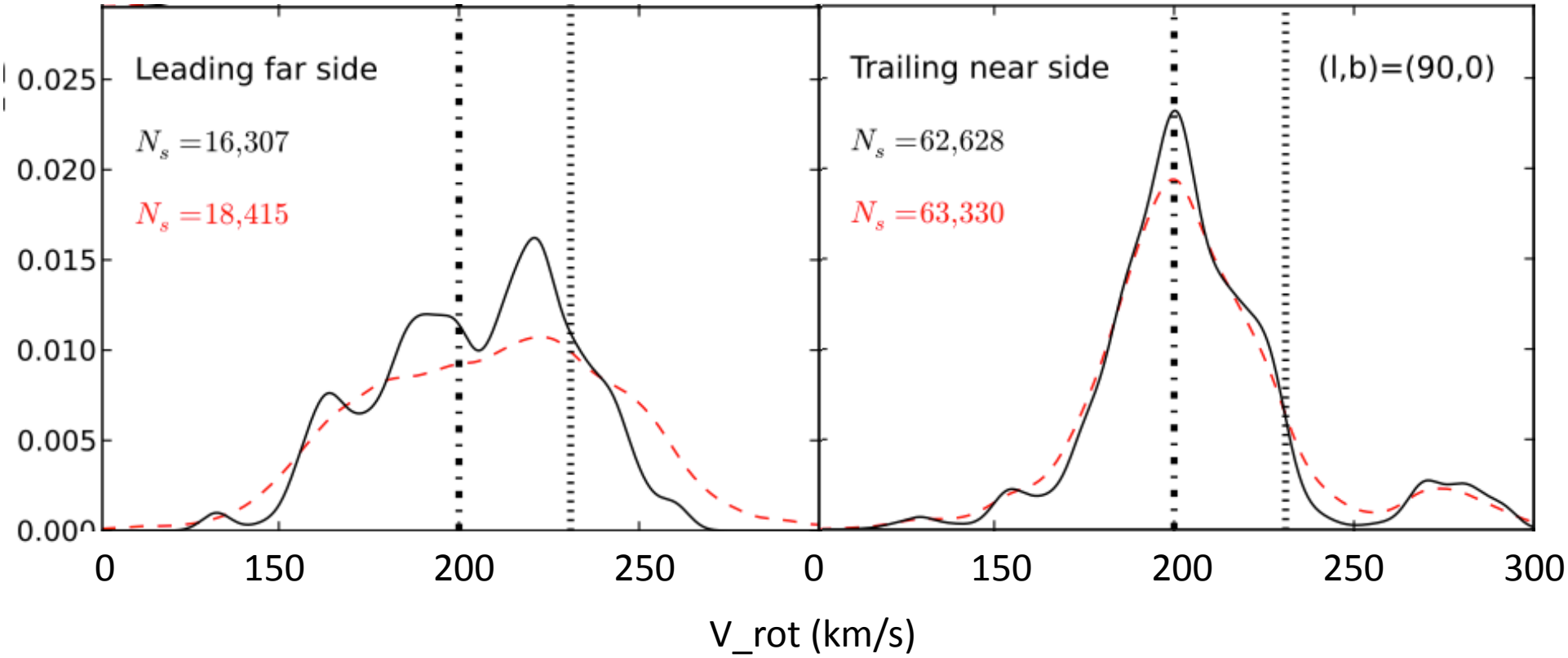


Density wave
(test particle)



Example: Transient spiral arm features

Comparing velocities in front and behind the spiral arm shows distinct features despite Gaia error



Summary

- From Hunt & Kawata (2015), MNRAS, 450, 2132
- Generates stellar data from *N*-body model
- Adds extinction estimate and Gaia like errors to make mock Gaia stellar catalogue
- Use to predict what Gaia might see with different theories of galactic dynamics