vcirc_test-pymc3

August 3, 2018

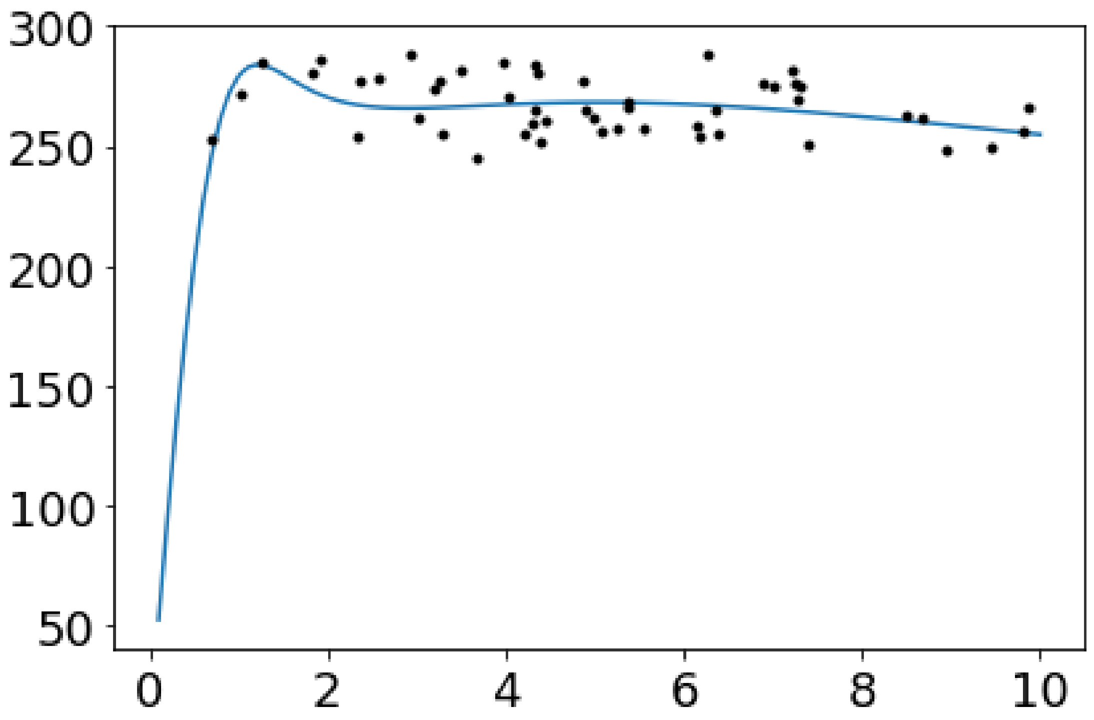
In [1]:
```
import numpy as np
import galpynamics
import galpynamics.dynamic_component as dc
import matplotlib.pyplot as plt
from galpynamics.dynamics import galpotential
from scipy import interpolate
import warnings
warnings.filterwarnings("ignore")
import seaborn as sns
from matplotlib.ticker import AutoMinorLocator
from matplotlib import colors
from matplotlib.colors import ListedColormap
from matplotlib.ticker import AutoMinorLocator
from matplotlib.ticker import MaxNLocator, MultipleLocator
cm = 'plasma'
```

In [2]:
```
#Generate some data
def rot_curve(distance,Mbulge,Rbulge,Mdisc,Rdisc,Zdisc,Denshalo,Rhalo):
    halo=dc.NFW_halo(d0=Denshalo, rs=Rhalo, mcut=100., e=0.) #Halo
    bulge=dc.valy_halo(mass=Mbulge, rb=Rbulge, mcut=3., e=0.) #Bulge
    disc=dc.Exponential_disc.thick(sigma0=Mdisc/(2*np.pi*Rdisc**2.),Rd=Rdisc, zd=Zdisc
    MW=galpotential(dynamic_components=(halo,disc,bulge))
    vgrid=MW.vcirc(distance,show_comp=True,nproc=1)
    return vgrid[:,-1]



dist=np.linspace(0.1,10,100)
np.random.seed(123)
d_GC = np.random.uniform(0.1,10,50)
v_rot = rot_curve(d_GC,2e10,0.5,5e10,2.5,0.3,3e7,10)
v_obs = np.random.normal(v_rot,10) #dispersion around rotation curve

plt.plot(dist, rot_curve(dist,2e10,0.5,5e10,2.5,0.3,3e7,10))
plt.plot(d_GC, v_obs, 'k.')
plt.show()
```




```
In [5]: #Working with theano variables
        import time
        import theano.tensor as tt
        from theano.compile.ops import as_op

        #####THEANO VERSION#####

        #Declaring function ready to work with theano variables using the decarator as_op to u
        @as_op(itypes=[tt.dvector,tt.dscalar,tt.dscalar,tt.dscalar,tt.dscalar,tt.dscalar,tt.dsc
        def rot_curve_theano(distance,Mbulge,Rbulge,Mdisc,Rdisc,Zdisc,Denshalo,Rhalo):
            halo=dc.NFW_halo(d0=Denshalo, rs=Rhalo, mcut=100., e=0.) #Halo
            bulge=dc.valy_halo(mass=Mbulge, rb=Rbulge, mcut=3., e=0.) #Bulge
            disc=dc.Exponential_disc.thick(sigma0=Mdisc/(2*np.pi*Rdisc**2.),Rd=Rdisc, zd=Zdisc
            MW=galpotential(dynamic_components=(halo,disc,bulge))
            vgrid=MW.vcirc(distance,show_comp=True,nproc=1)
            return vgrid[:,-1]

        #Variables using _shared theano tensor to pass from pure python variables to theano te
        distance=tt._shared(d_GC)
        Mbulge=tt._shared(np.cast['float64'](2.0e10))
        Rbulge=tt._shared(np.cast['float64'](0.5))
        Dhalo = tt._shared(np.cast['float64'](3e7))
        Rhalo = tt._shared(np.cast['float64'](10))
        Mdisc = tt._shared(np.cast['float64'](5e10))
```

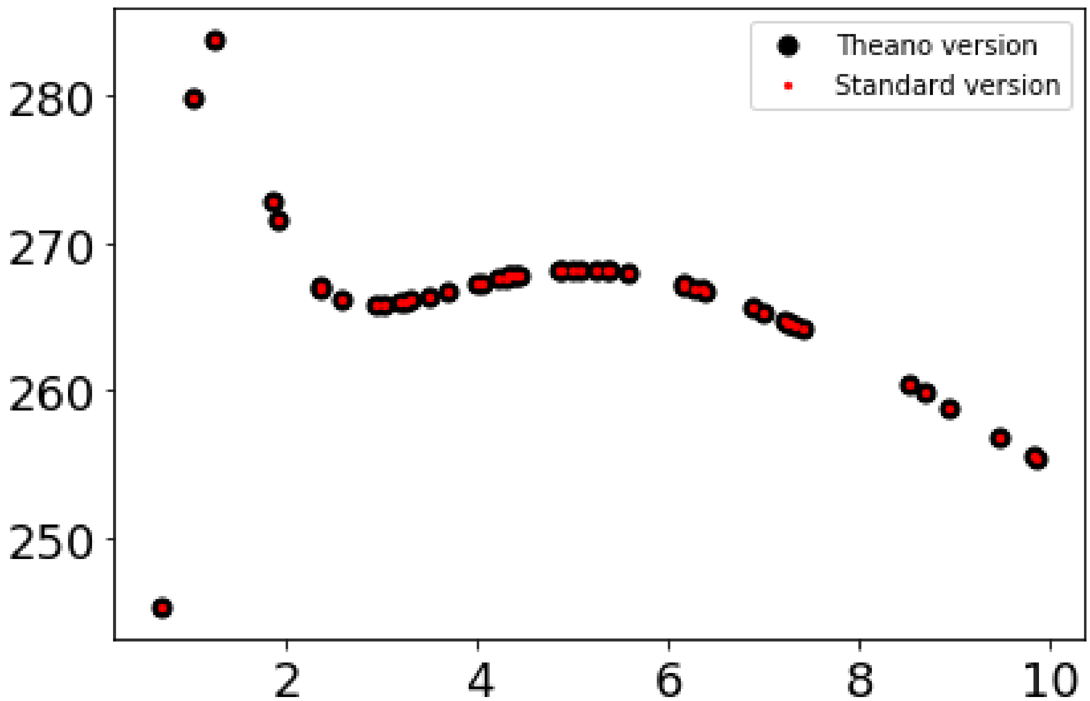
```
Rdisc = tt._shared(np.cast['float64'](2.5))
Zdisc = tt._shared(np.cast['float64'](0.3))

#timing
t1=time.time()
v_rot_theano = rot_curve_theano(distance,Mbulge,Rbulge,Mdisc,Rdisc,Zdisc,Dhalo,Rhalo)
t2a=time.time()
v_rot=v_rot_theano.eval()
t2b=time.time()
print('Theano version time (estimating vrot)',t2a-t1)
print('Theano version time (estimating vrot+cast to numpy array)',t2b-t1)


###STANDARD VERSION
#timing
t1=time.time()
v_rot = rot_curve(d_GC,2.0e10,0.5,5e10,2.5,0.3,3e7,10)
t2=time.time()
print('Standard version time (estimating vrot)',t2-t1)

#Comparative plot
plt.scatter(d_GC,v_rot,label='Theano version',c='black',s=50) #THEANO
plt.scatter(d_GC,v_rot,s=5,label='Standard version',c='red') #STANDARD
plt.legend()
plt.show()
```

```
Theano version time (estimating vrot) 0.00011873245239257812
Theano version time (estimating vrot+cast to numpy array) 0.5320971012115479
Standard version time (estimating vrot) 0.6339089870452881
```



In [6]:
```
#PYMC3#
import pymc3 as pm
import corner



RC_model = pm.Model()
with RC_model as model_deterministic:
    # Priors for unknown model parameters
    Dhalo = pm.Uniform('Dhalo', lower=1e+6,upper=1e+8)
    Rhalo = pm.Uniform('Rhalo', lower=1.,upper=50.)
    Mdisc = pm.Uniform('Mdisc', lower=1e+10,upper=1e+12) #pm.Normal('Mdisc', mu=1e+10,
    Rdisc = pm.Normal('Rdisc', mu=2.5, sd=0.1)#pm.Uniform('Rdisc', lower=1.,upper=10.)
    Zdisc = pm.Normal('Zdisc', mu=0.3, sd=0.1)#pm.Uniform('Hdisc', lower=0.05,upper=0.

    #Constant parameters
    distance=tt._shared(d_GC)
    Mbulge=tt._shared(np.cast['float64'](2.0e10))
    Rbulge=tt._shared(np.cast['float64'](0.5))

    # Expected value of outcome (model)
    v_rot = rot_curve_theano(distance,Mbulge,Rbulge,Mdisc,Rdisc,Zdisc,Dhalo,Rhalo)

    # Likelihood (sampling distribution) of observations
```

```python
        v_fit = pm.Normal('v_fit', mu=v_rot, sd=10, observed=v_obs)


    with RC_model:

        #Number of threads
        nproc=4
        #Number of burn-in samples
        Nburn=10
        # Number of posterios samples
        Npost=10
        # instantiate sampler
        step = pm.Metropolis()
        # draw  posterior samples
        trace = pm.sample(draws=Npost,step=step,njobs=nproc,tune=Nburn)
```

```
Only 10 samples in chain.
Multiprocess sampling (4 chains in 4 jobs)
CompoundStep
>Metropolis: [Zdisc]
>Metropolis: [Rdisc]
>Metropolis: [Mdisc]
>Metropolis: [Rhalo]
>Metropolis: [Dhalo]
Sampling 4 chains: 100%|| 80/80 [01:26<00:00,  3.28s/draws]
```

```python
In [7]: pt=pm.plot_posterior(trace)
```