Running_master

November 29, 2018

```
In [1]: %pylab inline
        from IPython.display import set_matplotlib_formats
        set_matplotlib_formats('pdf', 'svg')
        import matplotlib.pyplot as plt
        plt.rcParams["image.cmap"] = "jet"
        import healpy as h
        from modules import binned_master
```

```
Populating the interactive namespace from numpy and matplotlib
```

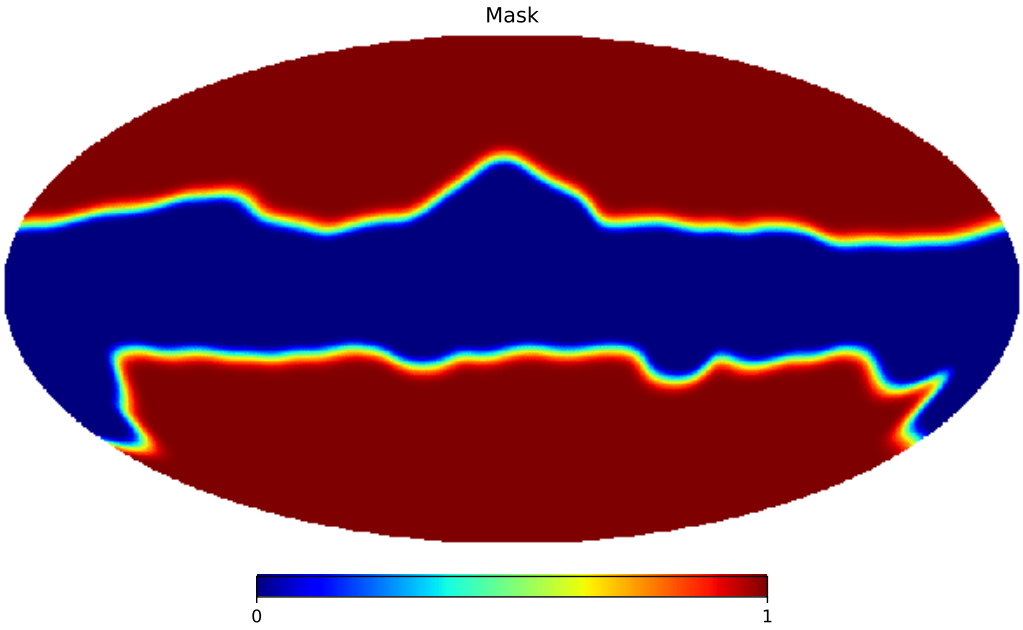
1 Master algorithm

The masked C_ℓ is related to the unmasked C_ℓ via the following relation,

$$\tilde{C}_\ell = \sum_{\ell'} M_{\ell\ell'} C_{\ell'}$$

2 Reading in the mask

```
In [46]: mask=h.read_map("./data/mask.fits",verbose=False) ; fsky=sum(mask)/size(mask)
         nside=h.get_nside(mask) ; lmax=2*nside ; ell=arange(lmax+1)
         h.mollview(mask,title="Mask")
```



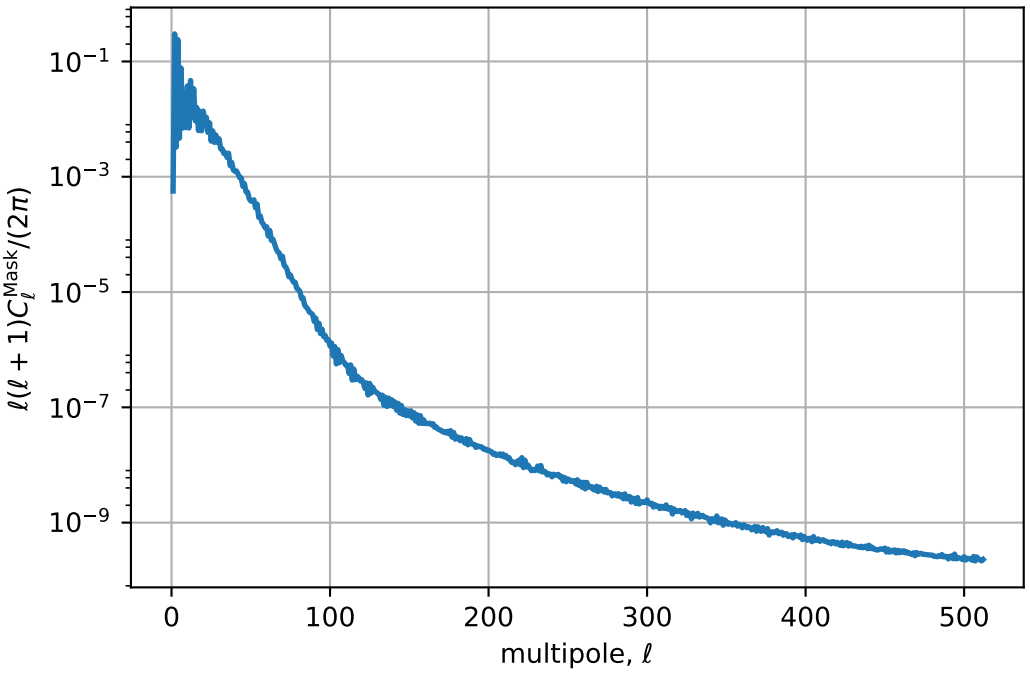
3 Computing the coupling matrix $M_{\ell\ell'}$ and its binned version

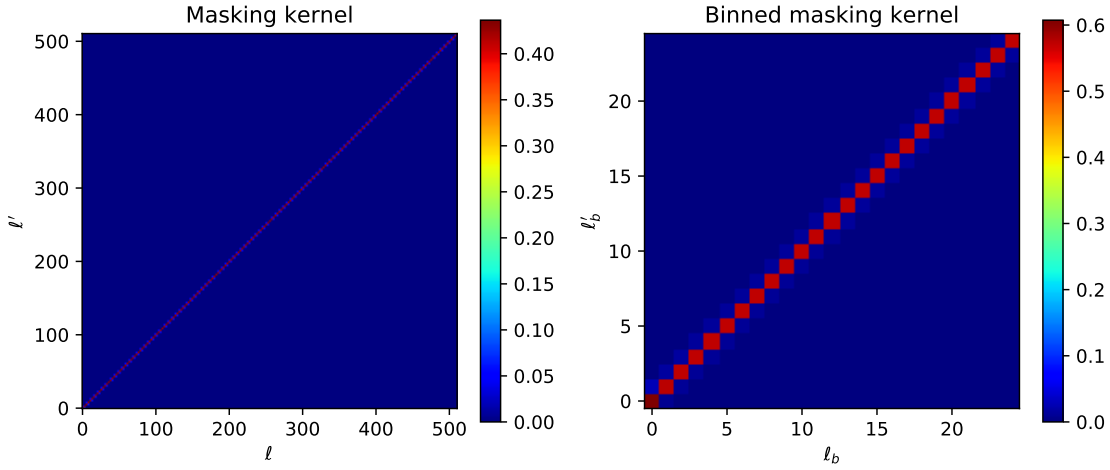
```
In [47]: cmblmin=2 ; cmblmax=lmax ; masklmax=2*nside
         bm=binned_master.binned_master(mask,cmblmin,cmblmax,masklmax)
         bm.setup_binning(20)
```

```
In [109]: figure()
          ell=arange(masklmax+1)
          plot(ell,ell*(ell+1)*bm.clmask/2/pi,lw=2)
          xlabel("multipole, $\ell$")
          ylabel(r"$\ell(\ell+1)C^{\rm Mask}_{\ell}/(2 \pi)$")
          grid()
          semilogy()

          f, (ax1, ax2) = plt.subplots(1, 2, sharey=False,figsize=(10, 4))
          im1=ax1.imshow(bm.mllp,origin="lower")
          f.colorbar(im1,ax=ax1)
          ax1.set_title("Masking kernel")
          ax1.set_xlabel("$\ell$") ; ax1.set_ylabel("$\ell'$")
          im2=ax2.imshow(bm.mbbp,origin="lower")
          f.colorbar(im2,ax=ax2)
          ax2.set_title("Binned masking kernel")
          ax2.set_xlabel("$\ell_b$") ; ax2.set_ylabel("$\ell_b'$")
```

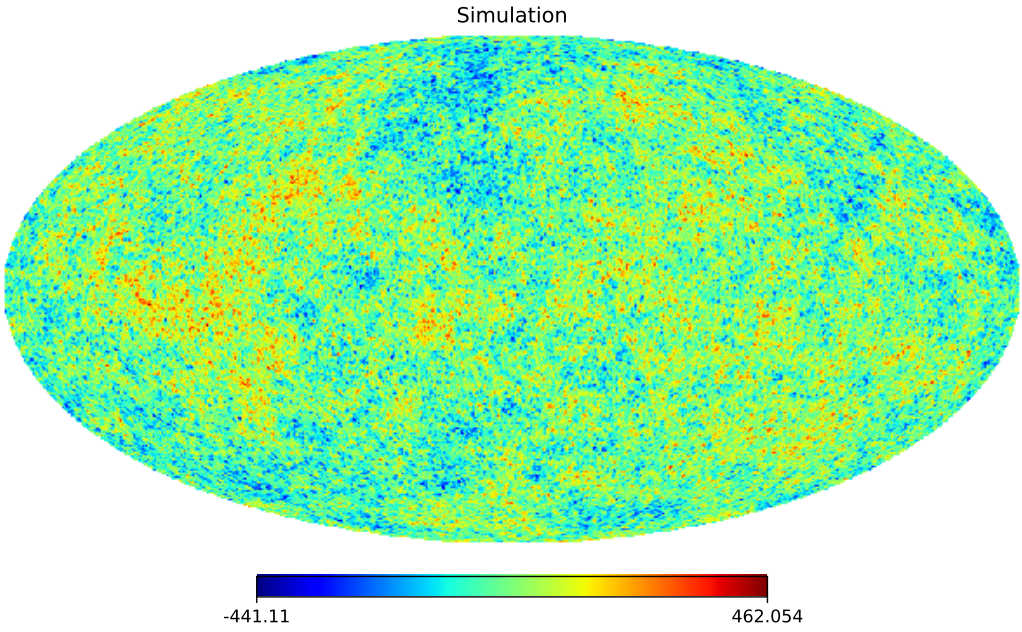
```
Out[109]: <matplotlib.text.Text at 0x11ca42810>
```

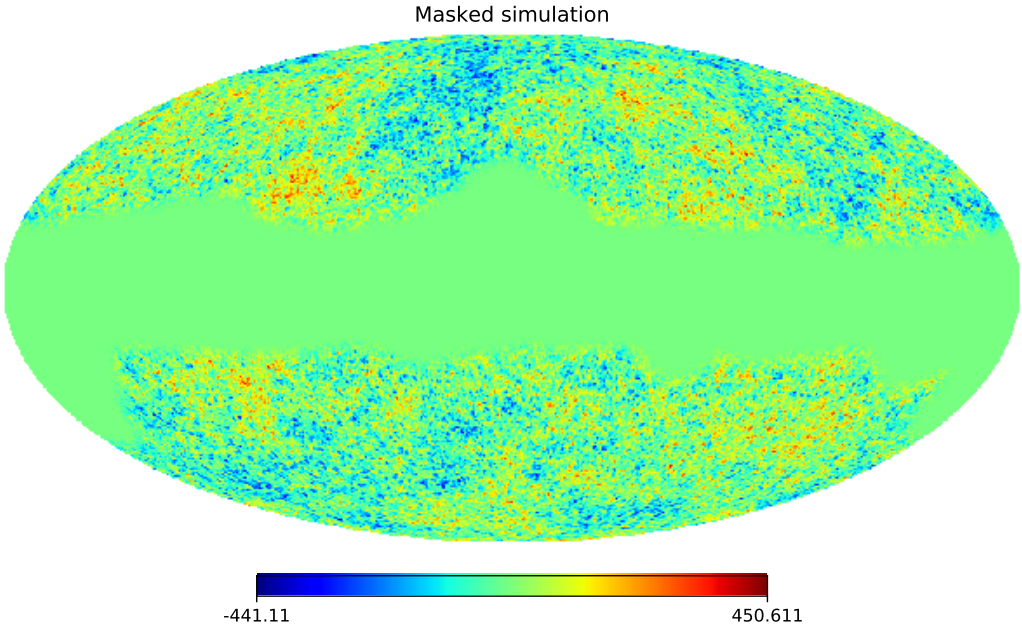




4 Generating a simulated CMB map and computing its power spectrum

```
In [53]: clthry=h.read_cl("./data/thrycl.fits")
         sim=h.synfast(clthry[0,:],nside,lmax=cmblmax,verbose=False,pixwin=False)
         h.mollview(sim,title="Simulation")
         h.mollview(sim*mask,title="Masked simulation")
```

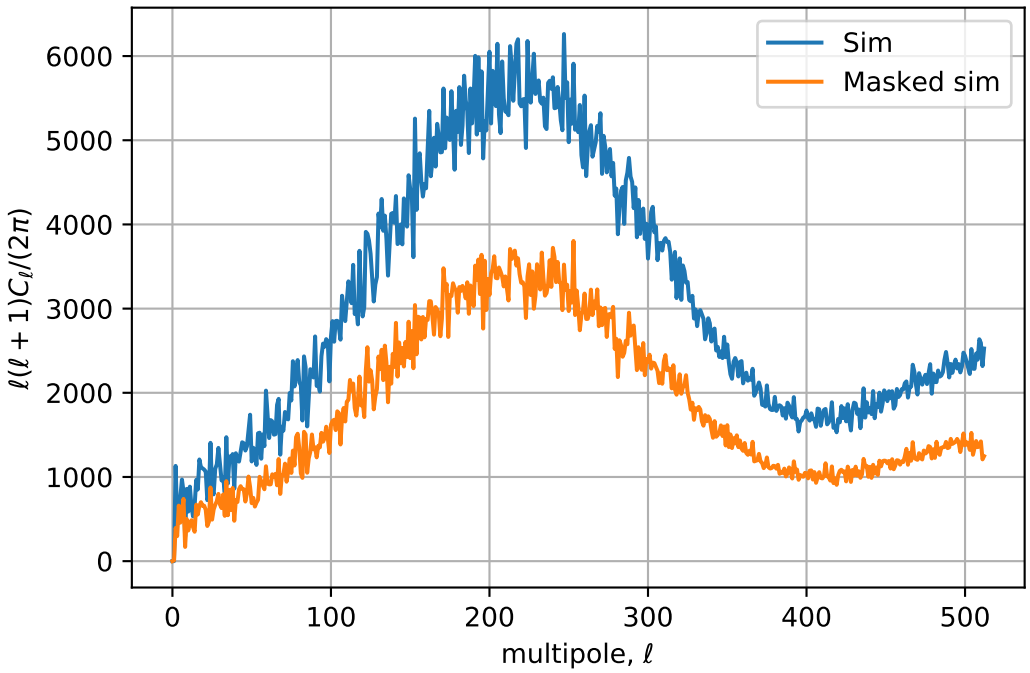




4.1 Power spectrum

```
In [98]: clsim=h.alm2cl(h.map2alm(sim,lmax=cmblmax))
         clsim_masked=h.alm2cl(h.map2alm(sim*mask,lmax=cmblmax))
         ell=arange(cmblmax+1)
```

```
figure()
plot(ell,ell*(ell+1)*clsim/(2.*pi),label="Sim")
plot(ell,ell*(ell+1)*clsim_masked/(2.*pi),label="Masked sim")
xlabel("multipole, $\ell$")
ylabel("$\ell(\ell+1)C_{\ell}/(2 \pi)$")
legend(loc=0)
grid()
```



5 Evaluating the master corrected spectrum:

$$C_\ell = \sum_{\ell'} M^{-1}_{\ell\ell'} \tilde{C}_{\ell'}$$

```
In [101]: clmcs=bm.return_mcs(clsim_masked)                  # Computing the master corrected sp
          lbin,clb=bm.return_binned_spectra(clsim)           # Binning the true spectrum
          lbin,clbm=bm.return_binned_spectra(clsim_masked) # Binning the masked spectrum
          lbin,clbmcs=bm.return_bmcs(clsim_masked)           # Computing the binned master corre
          lbin,cltb=bm.return_binned_spectra(clthry[0,:cmblmax+1])          # Computing the bin

          f, (ax1, ax2) = plt.subplots(1, 2, sharey=False,figsize=(10, 4))
          ax1.plot(ell,ell*(ell+1)*clsim/2./pi,"r-",lw=2,label="True")
          ax1.plot(ell,ell*(ell+1)*clsim_masked/2./pi,"b-",lw=2,label="Masked")
          ax1.plot(ell,ell*(ell+1)*clmcs/2./pi,"g--",lw=2,label="Master corrected")
```

```
ax1.plot(ell,ell*(ell+1)*clthry[0,:cmblmax+1]/2./pi,"k-",lw=2,alpha=0.3)
ax1.plot(lbin,cltb,"k.",lw=2,label="Theory")
ax1.set_xlabel("multipole, $\ell$")
ax1.set_ylabel("$\ell(\ell+1)C_{\ell}/(2 \pi)$")
ax1.legend(loc=0,title="Unbinned")
ax1.grid()
ax2.plot(lbin,clb,"r-",lw=2,label="True")
ax2.plot(lbin,clbm,"b--",lw=2,label="Masked")
ax2.plot(lbin,clbmcs,"g--",lw=2,label="Master corrected")
ax2.plot(ell,ell*(ell+1)*clthry[0,:cmblmax+1]/2./pi,"k-",lw=2,alpha=0.3)
ax2.plot(lbin,cltb,"k.",lw=2,label="Theory")
ax2.set_xlabel("multipole, $\ell$")
ax2.set_ylabel("$\ell(\ell+1)C_{\ell}/(2 \pi)$")
ax2.legend(loc=0,title="Binned")
ax2.grid()
plt.tight_layout()
```