checking_speckles

July 18, 2020

[1]:
```
%matplotlib inline
```

[2]:
```
import numpy as np
import matplotlib.pyplot as plt
from skbeam.core.correlation import multi_tau_auto_corr

plt.rc('lines', linewidth=2)
```

Create reference set of speckles

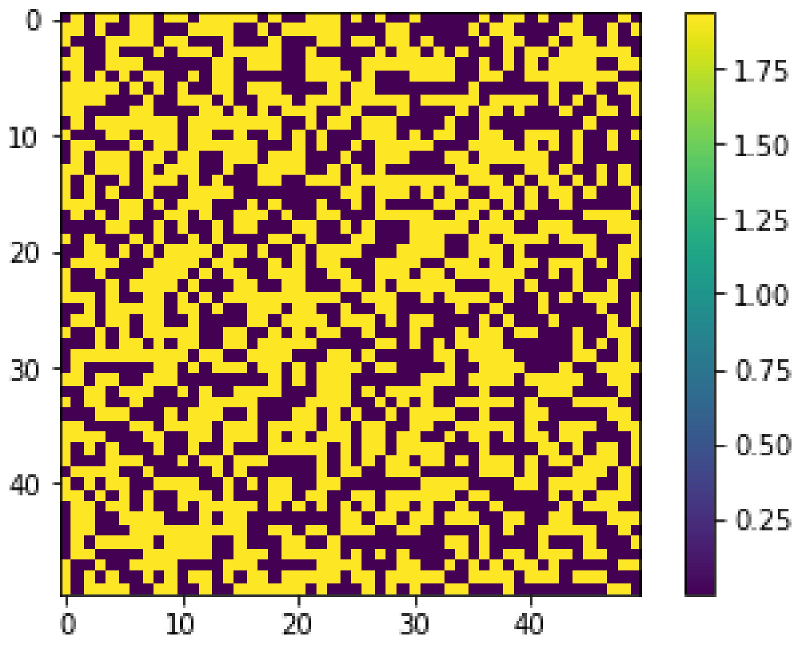
[3]:
```
def to_beta(g):
    return (g-1)/(g[1]-1)
```

[4]:
```
npix = 50
nimages = 400
perfect_speckle_image = 1e-6 + 2*np.round(np.random.rand(npix, npix))
perfect_speckle_image /= perfect_speckle_image.mean()
```

[5]:
```
fig, ax = plt.subplots()

art = ax.imshow(perfect_speckle_image, interpolation=None)
plt.colorbar(art, ax=ax)
```

[5]:
```
<matplotlib.colorbar.Colorbar at 0x7f1e65849160>
```



Analyze situation for static signal

```
[6]: M = np.ones(nimages)[:, np.newaxis, np.newaxis] * perfect_speckle_image[np.
      ↪newaxis, :]
     Moffset = M + 1
     Mnoise = M + np.array([1*np.random.rand(npix, npix) for _ in range(nimages)])

     tau = np.arange(nimages//4, dtype=np.float)
     tau[0] = np.NaN # ignore first point
```

```
[7]: g2, steps = multi_tau_auto_corr(1, M.shape[0]//4, np.ones_like(M[0], dtype=np.
      ↪int), M)
     g2_offset, steps = multi_tau_auto_corr(1, M.shape[0]//4, np.ones_like(M[0],␣
      ↪dtype=np.int), Moffset)
     g2_noise, steps = multi_tau_auto_corr(1, M.shape[0]//4, np.ones_like(M[0],␣
      ↪dtype=np.int), Mnoise)
```

```
[8]: fig, axs = plt.subplots(1, 2, figsize=(8, 4))

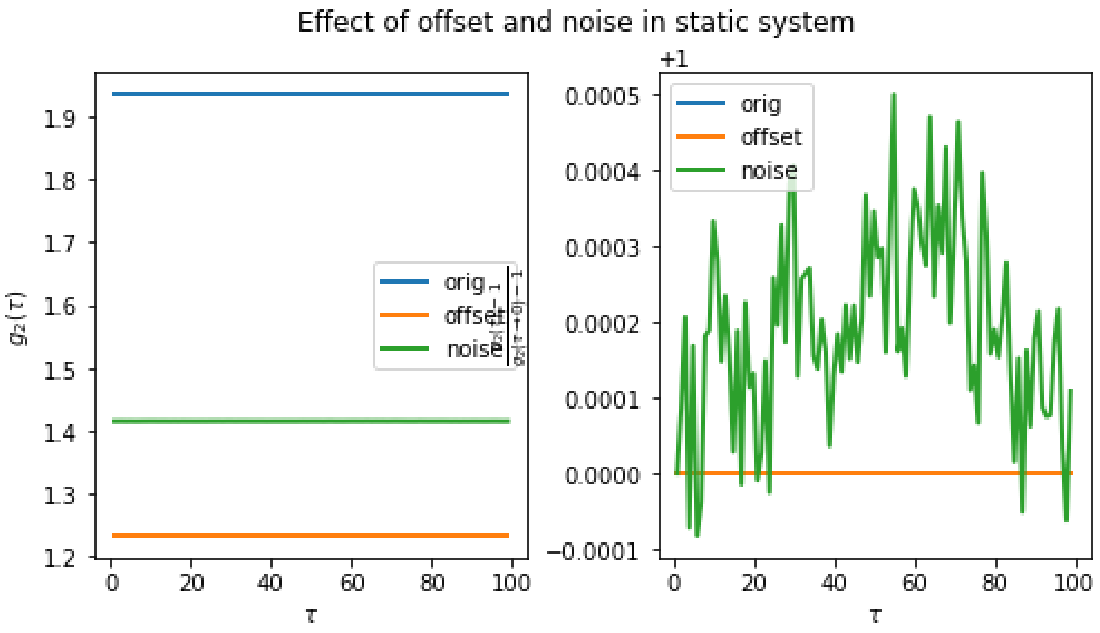
     ax = axs[0]
     ax.plot(tau, g2[:, 0], label='orig')
     ax.plot(tau, g2_offset[:, 0], label='offset')
     ax.plot(tau, g2_noise[:, 0], label='noise')

     ax.set_xlabel(r'$\tau$')
     ax.set_ylabel(r'$g_2(\tau$)')
ax.legend()

ax = axs[1]
ax.plot(tau, to_beta(g2[:, 0]), label='orig')
ax.plot(tau, to_beta(g2_offset[:, 0]), label='offset')
ax.plot(tau, to_beta(g2_noise[:, 0]), label='noise')

#ax.set_ylim([.99, 1.01])
ax.set_xlabel(r'$\tau$')
ax.set_ylabel(r'$\frac{g_2(\tau)-1}{g_2(\tau \rightarrow 0)-1}$')
ax.legend()

fig.suptitle('Effect of offset and noise in static system')
fig.subplots_adjust(wspace=.3)
```



Create and analyze signal for dynamic situation

[9]:
```
M_decay = np.zeros_like(M)
M_decay[0] = perfect_speckle_image
for i in range(1, nimages):
    for _ in range(50):
        r1 = np.floor(npix*np.random.rand(1))[0]
        r2 = np.floor(npix*np.random.rand(1))[0]
        image = M_decay[0]
        image[int(r1), int(r2)] = 1e-6 + 2*np.round(np.random.rand(1))
    M_decay[i] = image/image.mean()
```

```
M_decay_offset = M_decay + 1
M_decay_noise = M_decay + np.array([1*np.random.rand(npix, npix) for _ in␣
↪range(nimages)])

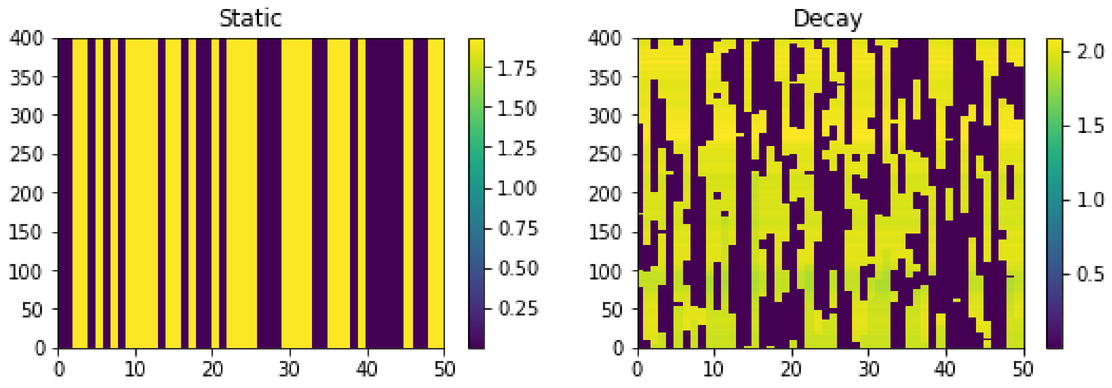
XX, YY = np.meshgrid(np.arange(npix), np.arange(npix))
M_decay_peak = M_decay + np.exp(-(((XX-25)/20)**2 + ((YY-25)/20)*2))
```

[10]:
```
fig, axs = plt.subplots(1, 2, figsize=(10, 3))

ax = axs[0]
art = ax.pcolor(M[:, 20, :])
plt.colorbar(art, ax=ax)
ax.set_title('Static')

ax = axs[1]
art = ax.pcolor(M_decay[:, 20, :])
plt.colorbar(art, ax=ax)
ax.set_title('Decay')
```

[10]:
```
Text(0.5, 1.0, 'Decay')
```



[11]:
```
g2_decay, steps = multi_tau_auto_corr(1, M.shape[0]//4, np.ones_like(M[0],␣
↪dtype=np.int), M_decay)
g2_decay_offset, steps = multi_tau_auto_corr(1, M.shape[0]//4, np.
↪ones_like(M[0], dtype=np.int), M_decay_offset)
g2_decay_noise, steps = multi_tau_auto_corr(1, M.shape[0]//4, np.
↪ones_like(M[0], dtype=np.int), M_decay_noise)
g2_decay_peak, steps = multi_tau_auto_corr(1, M.shape[0]//4, np.ones_like(M[0],␣
↪dtype=np.int), M_decay_peak)
```

```
[12]: fig, axs = plt.subplots(1, 2, figsize=(8, 4))

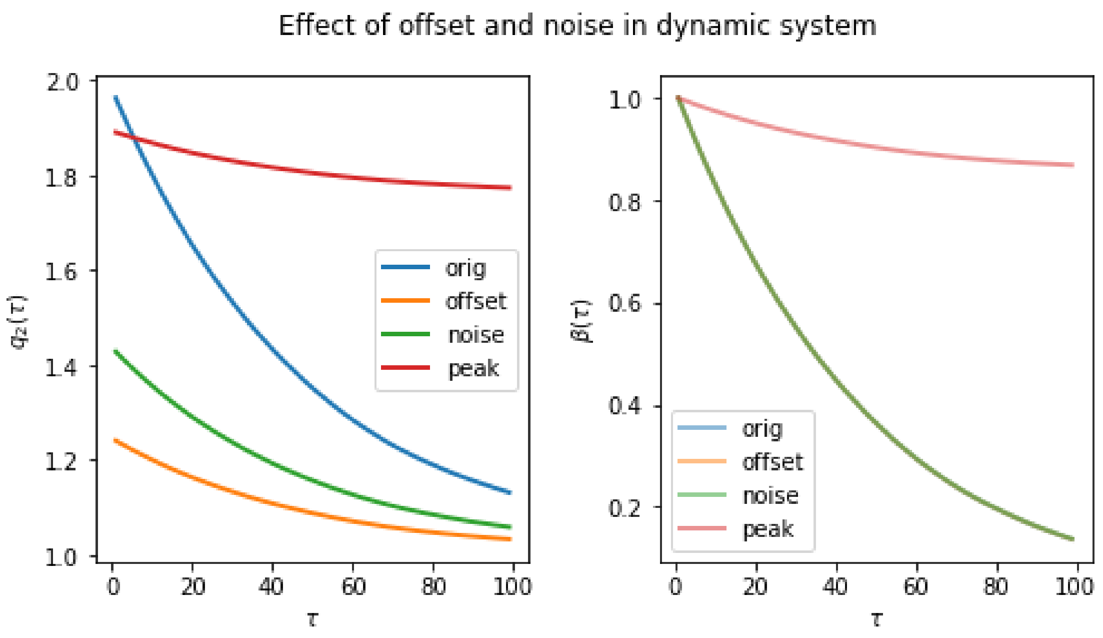
      ax = axs[0]
      ax.plot(tau, g2_decay[:, 0], label='orig')
      ax.plot(tau, g2_decay_offset[:, 0], label='offset')
      ax.plot(tau, g2_decay_noise[:, 0], label='noise')
      ax.plot(tau, g2_decay_peak[:, 0], label='peak')

      ax.set_xlabel(r'$\tau$')
      ax.set_ylabel(r'$q_2(\tau$)')
      ax.legend()

      ax = axs[1]
      alpha = .5
      ax.plot(tau, to_beta(g2_decay[:, 0]), alpha=alpha, label='orig')
      ax.plot(tau, to_beta(g2_decay_offset[:, 0]), alpha=alpha, label='offset')
      ax.plot(tau, to_beta(g2_decay_noise[:, 0]), alpha=alpha, label='noise')
      ax.plot(tau, to_beta(g2_decay_peak[:, 0]), alpha=alpha, label='peak')
      ax.set_ylabel(r'$\frac{g_2(\tau)-1}{g_2(\tau \rightarrow 0)-1}$')

      ax.set_xlabel(r'$\tau$')
      ax.set_ylabel(r'$\beta(\tau$)')
      ax.legend()

      fig.suptitle('Effect of offset and noise in dynamic system')
      fig.subplots_adjust(wspace=.3)
```



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[ ]:
```