

test_corr

February 21, 2023

```
[1]: import at
import sys
import numpy as np
from pathlib import Path
if sys.version_info.minor < 9:
    from importlib_resources import files, as_file
else:
    from importlib.resources import files, as_file
from scipy.stats import norm
from at import checktype, Monitor, Quadrupole
```

```
[2]: fname = 'hmba.mat'
with as_file(files('machine_data') / fname) as path:
    hmba_lattice = at.load_lattice(path)
```

```
[3]: from at import Observable, ObservableList, OrbitObservable,
↳GlobalOpticsObservable, LocalOpticsObservable
from at import MatrixObservable, TrajectoryObservable, EmittanceObservable,
↳LatticeObservable
r_in = np.zeros(6)
r_in[0] = 0.001
r_in[2] = 0.001
```

```
[4]: obs1=ObservableList(hmba_lattice)
```

```
[5]: obs1.append(OrbitObservable(at.Monitor, axis='x'))
```

```
[6]: obs2=ObservableList(hmba_lattice)
```

```
[7]: obs2.append(LocalOpticsObservable(at.Monitor, 'beta', plane=1, target=7.0,
↳bounds=(-np.inf, 0.0)))
```

check addition:

```
[8]: allobs = obs1 + obs2
```

Full transfer matrix to BPM02

```
[9]: allobs.append(MatrixObservable("BPM_02", axis=None))
```

Maximum of vertical beta on monitors:

```
[10]: allobs.append(LocalOpticsObservable(at.Monitor, 'beta', plane='v', statfun=np.  
      ↪max))
```

First 4 coordinates of the closed orbit at Quadrupoles

```
[11]: allobs.append(LocalOpticsObservable(at.Quadrupole, 'closed_orbit',  
      ↪plane=slice(4), target=0.0, weight=1.e-6))
```

Phase advance between elements 33 and 101:

```
[12]: def phase_advance(ring, elemdata):  
      mu = elemdata.mu  
      return (mu[-1] - mu[0])  
  
      allobs.append(LocalOpticsObservable([33, 101], phase_advance, use_integer=True,  
      ↪summary=True))
```

```
[13]: allobs.append(GlobalOpticsObservable('tune', plane=0, use_integer=True))
```

```
[14]: allobs.append(LocalOpticsObservable(at.End, 'mu', use_integer=True))
```

```
[15]: allobs.append(GlobalOpticsObservable('chromaticity', plane=Ellipsis))
```

Average of sextupole strengths:

```
[16]: allobs.append(LatticeObservable(at.Sextupole, 'H', statfun=np.mean))
```

```
[17]: allobs.append(EmittanceObservable('emittances', plane='x'))
```

```
[18]: def circumference(ring):  
      return ring.get_s_pos(len(ring))[0]  
      allobs.append(Observable(circumference))
```

```
[19]: allobs.append(TrajectoryObservable(at.Monitor, axis='px'))
```

Evaluate all:

```
[20]: allobs.evaluate(hmba_lattice.enable_6d(copy=True), r_in=r_in, initial=True)
```

Extract a single Observable value:

```
[21]: allobs[5].value
```

```
[21]: array([9.38969042e+00, 2.99742405e+00, 1.75857592e-16])
```

Get the list of all values

```
[22]: allobs.values
```

```

[22]: [array([-3.02189464e-09,  4.50695130e-07,  4.08205818e-07,  2.37899969e-08,
          -1.31783561e-08,  2.47230794e-08, -2.95310770e-08, -4.05598110e-07,
          -4.47398092e-07, -2.24850671e-09]),
array([5.30279703,  7.17604152,  6.55087808,  2.31448878,  3.40498445,
          3.405044  ,  2.3146451  ,  6.55106241,  7.17614175,  5.30283837]),
array([[[-1.08194106e+00,  3.18809568e+00,  0.00000000e+00,
          0.00000000e+00,  8.22407787e-02, -1.72158979e-05],
        [-6.80522735e-01,  1.08099571e+00,  0.00000000e+00,
          0.00000000e+00,  4.90131193e-02, -1.02601760e-05],
        [ 0.00000000e+00,  0.00000000e+00,  7.55929650e-01,
          3.87059271e+00,  0.00000000e+00,  0.00000000e+00],
        [ 0.00000000e+00,  0.00000000e+00, -6.79279293e-01,
          -2.15524755e+00,  0.00000000e+00,  0.00000000e+00],
        [-1.13307033e-08, -1.08615007e-07,  0.00000000e+00,
          0.00000000e+00,  9.99995907e-01, -2.09334442e-04],
        [ 2.93742206e-03,  6.73567963e-02,  0.00000000e+00,
          0.00000000e+00,  2.83582526e-04,  9.99999941e-01]]]),
7.176141753340505,
array([[[-3.02810060e-09, -1.45845184e-10,  0.00000000e+00,
          0.00000000e+00],
        [-1.78478172e-09,  2.17266512e-09,  0.00000000e+00,
          0.00000000e+00],
        [ 2.06038282e-07,  1.68970733e-07,  0.00000000e+00,
          0.00000000e+00],
        [ 4.63461951e-07,  2.65112226e-07,  0.00000000e+00,
          0.00000000e+00],
        [ 4.92846979e-07, -2.48829204e-09,  0.00000000e+00,
          0.00000000e+00],
        [ 2.39068213e-07, -2.69323539e-07,  0.00000000e+00,
          0.00000000e+00],
        [ 2.24947609e-08, -2.55612472e-08,  0.00000000e+00,
          0.00000000e+00],
        [-2.95803078e-08, -2.51342824e-08,  0.00000000e+00,
          0.00000000e+00],
        [ 3.86437997e-08,  4.66072137e-08,  0.00000000e+00,
          0.00000000e+00],
        [-1.14693069e-08, -5.89624566e-08,  0.00000000e+00,
          0.00000000e+00],
        [-1.92472284e-07, -1.36142852e-07,  0.00000000e+00,
          0.00000000e+00],
        [-4.58527423e-07, -2.67107396e-07,  0.00000000e+00,
          0.00000000e+00],
        [-4.90185496e-07, -2.06357882e-09,  0.00000000e+00,
          0.00000000e+00],
        [-2.42425061e-07,  2.63615692e-07,  0.00000000e+00,
          0.00000000e+00],
        [-8.04953230e-10, -1.24373300e-09,  0.00000000e+00,
          0.00000000e+00],

```

```

    0.00000000e+00],
    [-1.92734997e-09, -1.83198102e-09, 0.00000000e+00,
     0.00000000e+00]]),
array([9.38969042e+00, 2.99742405e+00, 1.75857592e-16]),
2.381563018580136,
array([[1.49638018e+01, 5.36820522e+00, 6.85248778e-04]]),
array([1.79196879e-01, 1.22425551e-01, 1.69916635e-04]),
-25.369212247139345,
1.3203910483370938e-10,
26.374287952316944,
array([ 0.00000000e+00, -6.94370474e-04, 6.07151649e-04, 2.38468291e-04,
        -6.81824078e-04, -4.78921797e-04, 4.41491589e-04, 7.01582199e-04,
        -6.05543962e-04, -9.78684823e-05])]
```

```
[23]: print(allobs)
```

location bound	Initial residual	Actual	Low bound	High
orbit[x]				
BPM_01	-3.02189e-09	-3.02189e-09	-	
-	0.0			
BPM_02	4.50695e-07	4.50695e-07	-	
-	0.0			
BPM_03	4.08206e-07	4.08206e-07	-	
-	0.0			
BPM_04	2.379e-08	2.379e-08	-	
-	0.0			
BPM_05	-1.31784e-08	-1.31784e-08	-	
-	0.0			
BPM_06	2.47231e-08	2.47231e-08	-	
-	0.0			
BPM_07	-2.95311e-08	-2.95311e-08	-	
-	0.0			
BPM_08	-4.05598e-07	-4.05598e-07	-	
-	0.0			
BPM_09	-4.47398e-07	-4.47398e-07	-	
-	0.0			
BPM_10	-2.24851e-09	-2.24851e-09	-	
-	0.0			
beta[v]				
BPM_01	5.3028	5.3028	-inf	
7.0	0.0			
BPM_02	7.17604	7.17604	-inf	
7.0	0.0309906			
BPM_03	6.55088	6.55088	-inf	
7.0	0.0			
BPM_04	2.31449	2.31449	-inf	
7.0	0.0			

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    BPM_05          3.40498          3.40498          -inf
7.0          0.0
    BPM_06          3.40504          3.40504          -inf
7.0          0.0
    BPM_07          2.31465          2.31465          -inf
7.0          0.0
    BPM_08          6.55106          6.55106          -inf
7.0          0.0
    BPM_09          7.17614          7.17614          -inf
7.0          0.0310259
    BPM_10          5.30284          5.30284          -inf
7.0          0.0
matrix
    BPM_02          [-1.082      ...] [-1.082      ...]          -
-    [ 0.0          ...]
amax(beta[v])
          7.17614          7.17614          -
-          0.0
closed_orbit[slice(None, 4, None)]
    QF1A          [-3.028e-09 ...] [-3.028e-09 ...] [ 0.0          ...] [ 0.0
...] [ 9.169e-06 ...]
    QD2A          [-1.785e-09 ...] [-1.785e-09 ...] [ 0.0          ...] [ 0.0
...] [ 3.185e-06 ...]
    QD3A          [ 2.06e-07 ...] [ 2.06e-07 ...] [ 0.0          ...] [ 0.0
...] [ 0.04245 ...]
    QF4A          [ 4.635e-07 ...] [ 4.635e-07 ...] [ 0.0          ...] [ 0.0
...] [ 0.2148 ...]
    QF4B          [ 4.928e-07 ...] [ 4.928e-07 ...] [ 0.0          ...] [ 0.0
...] [ 0.2429 ...]
    QD5B          [ 2.391e-07 ...] [ 2.391e-07 ...] [ 0.0          ...] [ 0.0
...] [ 0.05715 ...]
    QF6B          [ 2.249e-08 ...] [ 2.249e-08 ...] [ 0.0          ...] [ 0.0
...] [ 0.000506 ...]
    QF8B          [-2.958e-08 ...] [-2.958e-08 ...] [ 0.0          ...] [ 0.0
...] [ 0.000875 ...]
    QF8D          [ 3.864e-08 ...] [ 3.864e-08 ...] [ 0.0          ...] [ 0.0
...] [ 0.001493 ...]
    QF6D          [-1.147e-08 ...] [-1.147e-08 ...] [ 0.0          ...] [ 0.0
...] [ 0.0001315 ...]
    QD5D          [-1.925e-07 ...] [-1.925e-07 ...] [ 0.0          ...] [ 0.0
...] [ 0.03705 ...]
    QF4D          [-4.585e-07 ...] [-4.585e-07 ...] [ 0.0          ...] [ 0.0
...] [ 0.2102 ...]
    QF4E          [-4.902e-07 ...] [-4.902e-07 ...] [ 0.0          ...] [ 0.0
...] [ 0.2403 ...]
    QD3E          [-2.424e-07 ...] [-2.424e-07 ...] [ 0.0          ...] [ 0.0
...] [ 0.05877 ...]
    QD2E          [-8.05e-10 ...] [-8.05e-10 ...] [ 0.0          ...] [ 0.0

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...] [ 6.479e-07 ...]
      QF1E      [-1.927e-09 ...] [-1.927e-09 ...] [ 0.0      ...] [ 0.0
...] [ 3.715e-06 ...]
phase_advance
- [ 9.39      ...] [ 9.39      ...] -
- [ 0.0      ...]
tune[h]
      2.38156      2.38156      -
- 0.0
mu
      End      [ 14.96      ...] [ 14.96      ...] -
- [ 0.0      ...]
chromaticity
- [ 0.1792     ...] [ 0.1792     ...] -
- [ 0.0      ...]
mean(H)
      -25.3692     -25.3692     -
- 0.0
emittances[h]
      1.32039e-10   1.32039e-10   -
- 0.0
circumference
      26.3743      26.3743      -
- 0.0
trajectory[px]
      BPM_01      0.0      0.0      -
- 0.0
      BPM_02      -0.00069437   -0.00069437   -
- 0.0
      BPM_03      0.000607152   0.000607152   -
- 0.0
      BPM_04      0.000238468   0.000238468   -
- 0.0
      BPM_05      -0.000681824   -0.000681824   -
- 0.0
      BPM_06      -0.000478922   -0.000478922   -
- 0.0
      BPM_07      0.000441492   0.000441492   -
- 0.0
      BPM_08      0.000701582   0.000701582   -
- 0.0
      BPM_09      -0.000605544   -0.000605544   -
- 0.0
      BPM_10      -9.78685e-05   -9.78685e-05   -
- 0.0

```