Fried spot size through optical system

December 19, 2016

1 Fried spot size calculations through an optical system

```
In [1]: %matplotlib inline

        import numpy as np
        import sympy as sp
        import matplotlib.pyplot as plt
        from IPython.display import display
        from enum import Enum

        sp.init_printing()
```

```
In [2]: lbda, D, r_0, A, M, f_3, d = sp.symbols("lambda, D, r_0, A, M, f_3, d")
```

These formula for single-spot Fried motion are taken from [Sarazin & Roddier 1989]

Two-spot differential motion is in the same order of magnitude and depends on the separation (0.3-0.8 * single-spot). A better treatment of two-spot differential motion is given in [Tokovinin 2002: From Differential Image Motion to Seeing], but I only found out about/understood that paper later on.

```
In [3]: sigma_m_sq = A * (lbda / D) ** (sp.Rational(1,3)) * (lbda / r_0) ** (sp.Rat
        sigma_m = sp.sqrt(sigma_m_sq)

        M_theta = f_3/M

        mag_sigma_m = sigma_m * M_theta

        display(sigma_m_sq)
        display(sigma_m)
        display(mag_sigma_m)
```

$$A\sqrt[3]{\frac{\lambda}{D}}\left(\frac{\lambda}{r_0}\right)^{\frac{5}{3}}$$

$$\sqrt{A\sqrt[3]{\frac{\lambda}{D}}\left(\frac{\lambda}{r_0}\right)^{\frac{5}{3}}}$$

$$\frac{f_3}{M}\sqrt{A\sqrt[3]{\frac{\lambda}{D}}\left(\frac{\lambda}{r_0}\right)^{\frac{5}{3}}}$$

```
In [5]: params = [(lbda, 500e-9), (D, 10e-3), (A, 0.36), (r_0, 10e-3), (f_3, 500),

        print("Single lens Fried spot motion [urad]:")
        display(sigma_m.subs(params).evalf() * 1e6)

        print("Optical system Fried spot motion [um]:")
        display(mag_sigma_m.subs(params).evalf()*1000)
```

```
Single lens Fried spot motion [urad]:
```

$$30.0$$

```
Optical system Fried spot motion [um]:
```

$$60.0$$

```
In [ ]:

In [ ]:

In [ ]:
```