Line Shapes Emitted from Spiral Structures around Symmetric Orbits of Supermassive Binary Black Holes

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Model

1) BHs
- Masses
M_{tot}, $Q = M_1/M_2$

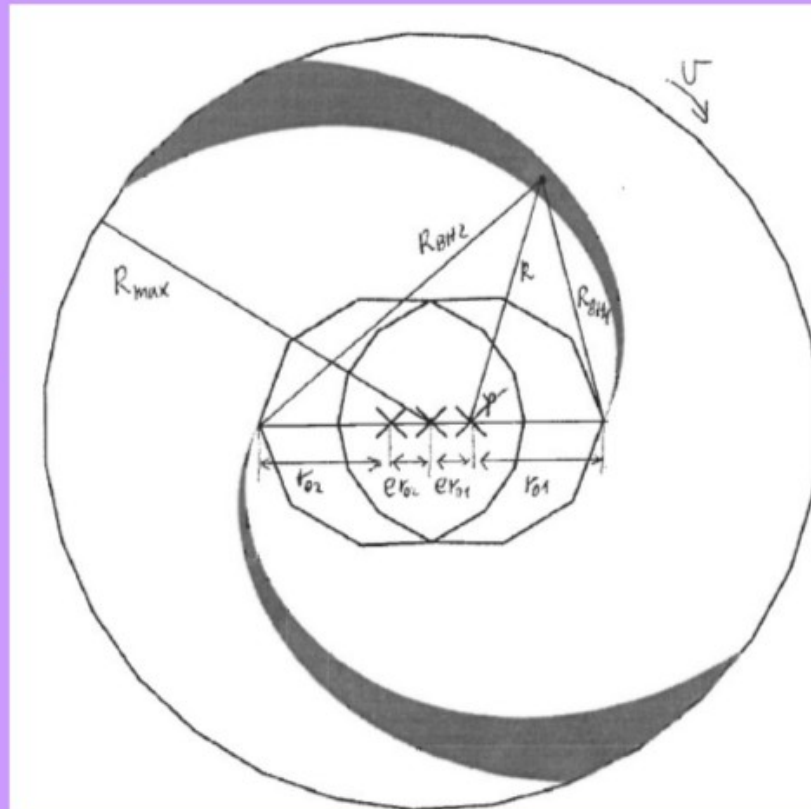- Emissivity: $q_{1,2}$

$$\epsilon \sim r_{BH1}^{-q_1} + r_{BH2}^{-q_2},$$

- Orbit: T, e, w

3) velocity
- Kepler equations of motion

- plus local turbulences

2) Spirals of gas and CB disk
- geometry of spirals: angle, thickness, (length)

$$R_2 = r_{02} e^{B\varphi}$$

- position of CB disk: *from simulations*

4) Angle of inclination i

$$r_{1,2} \sin i = (1.3751 \times 10^4)(1-e^2)^{1/2} K_{1,2} T \ \mathrm{km},$$

$$M_{1,2} \sin i = (1.0361 \times 10^{-7})(1-e^2)^{3/2}(K_1 + K_2)^2 K_{2,1} T \ M_\odot$$

$r_{01,02} \sim 0.001 - 0.005$ pc
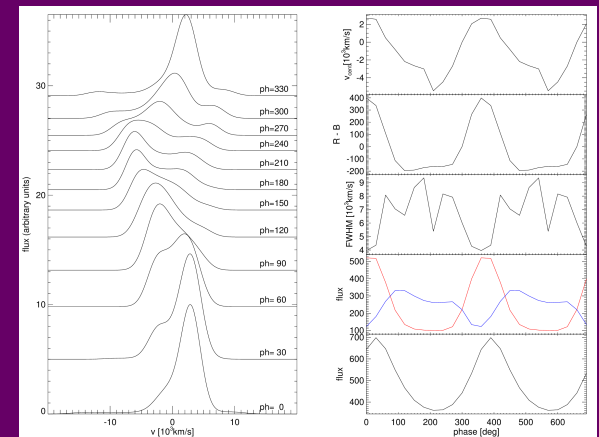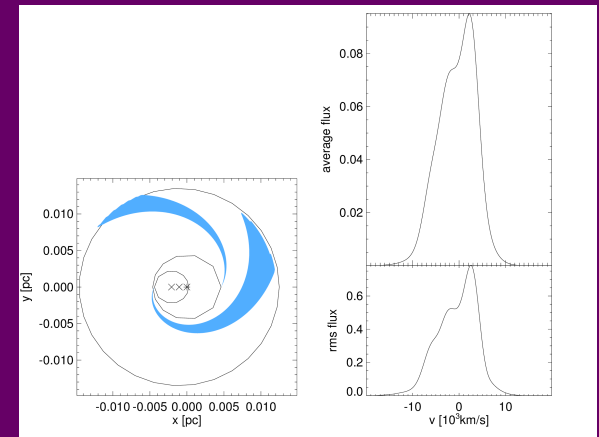
Line profiles of asymmetric SMBBHs
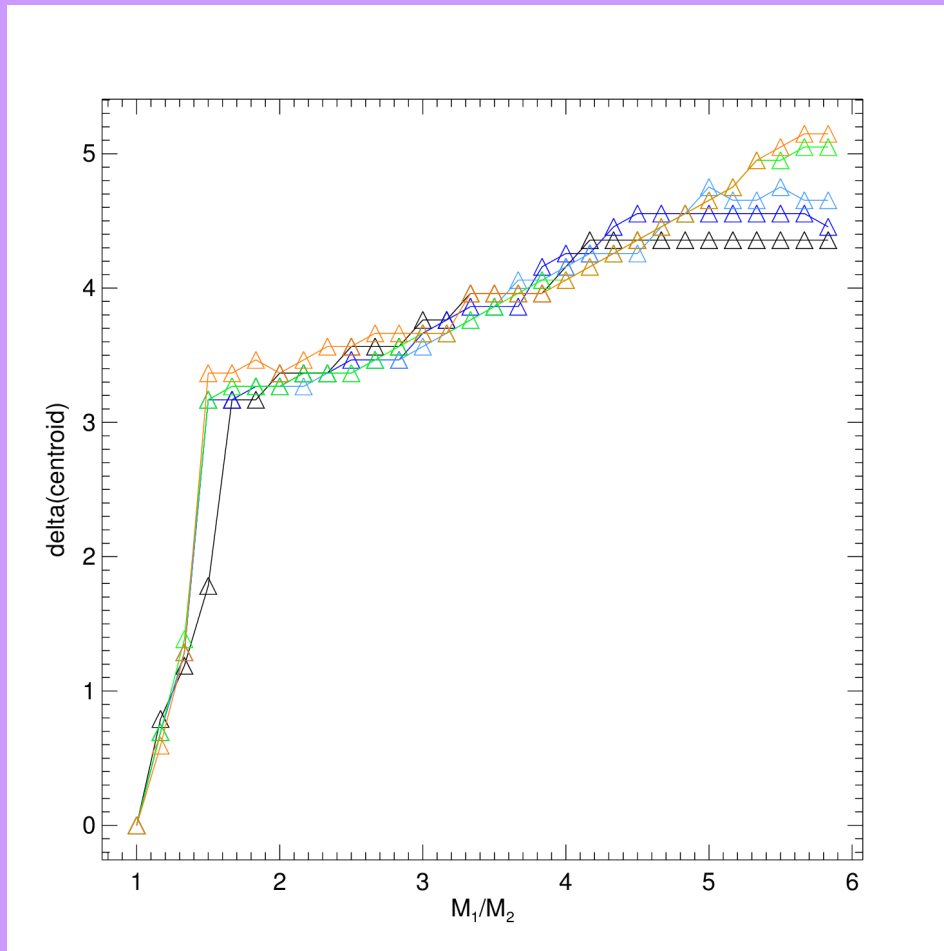
- Different mass ratio

    $Q = M_1/M_2$

- Elliptical orbit:

    e – eccentricity

    w – orientation of the
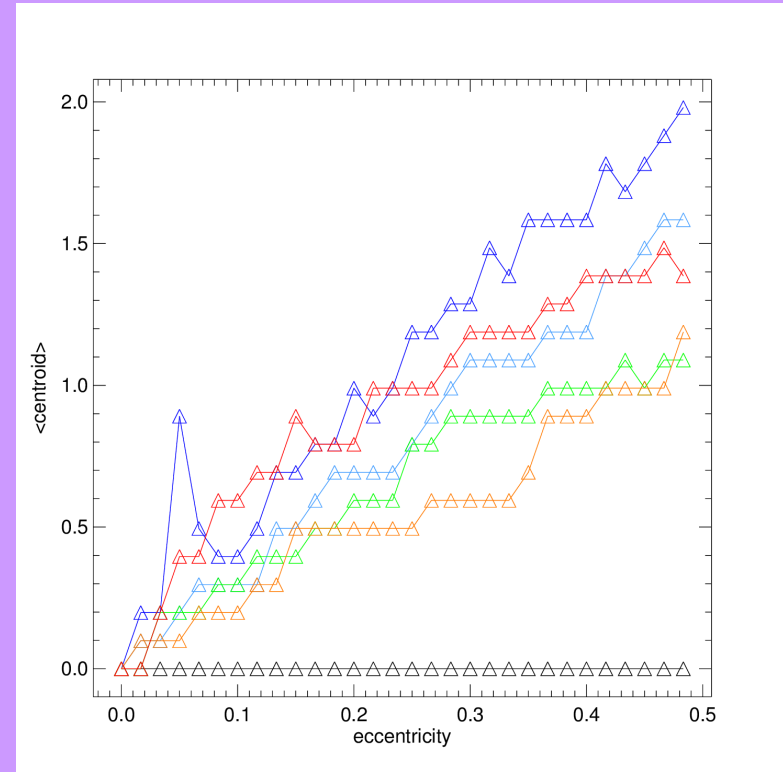
    orbit

Q=M$_1$/M$_2$

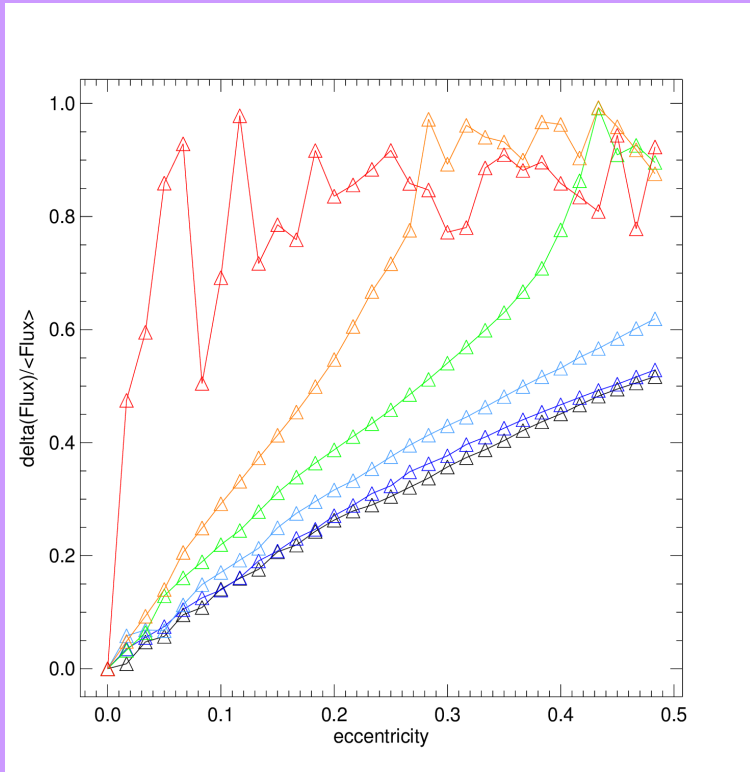As Q increases:

I$\Delta v_{centroid}$I increases,
IΔ(R-B)I increases,
<FWHM> decreases,
Lines more single-peaked

e

As e increases: ΔF increases, I<$v_{centroid}$>I increases, I<R – B>I increases

As w changes: B > R, then again R > B