3D Models of Maser Flares

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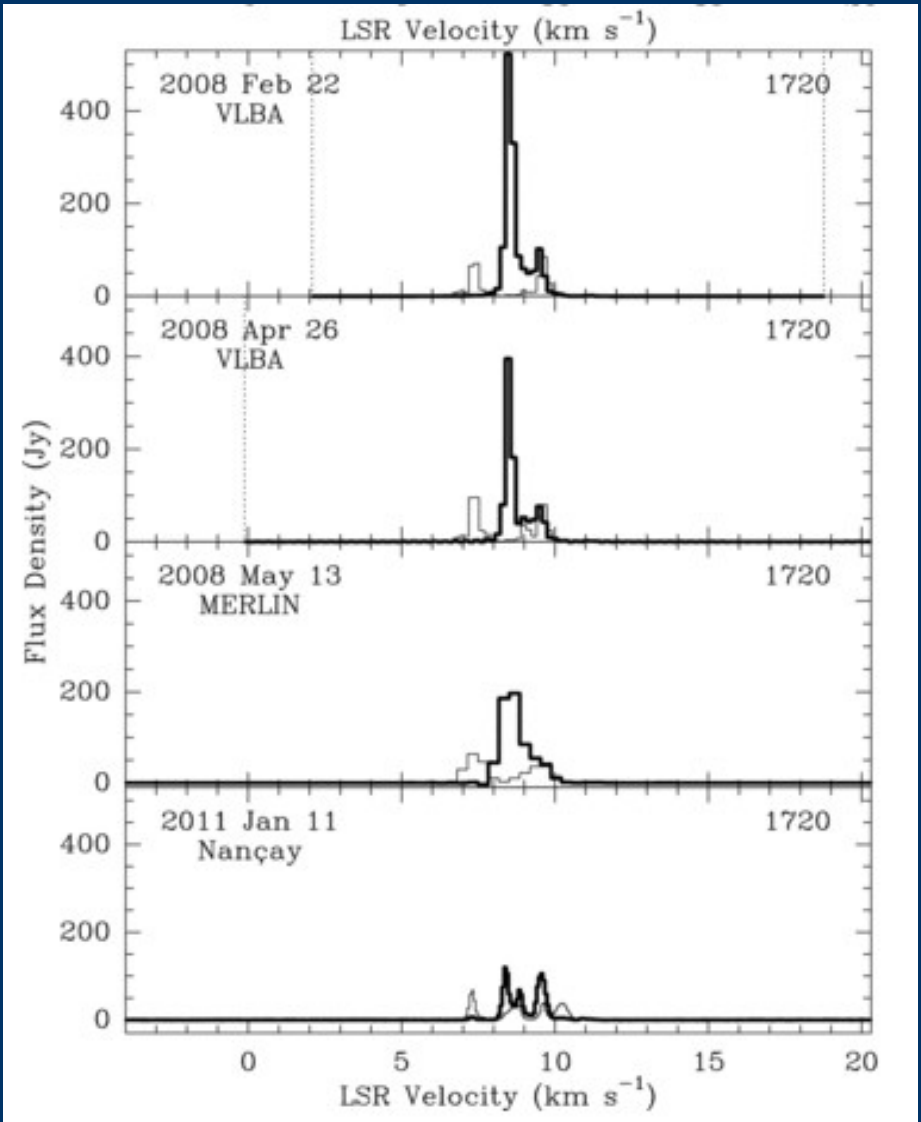
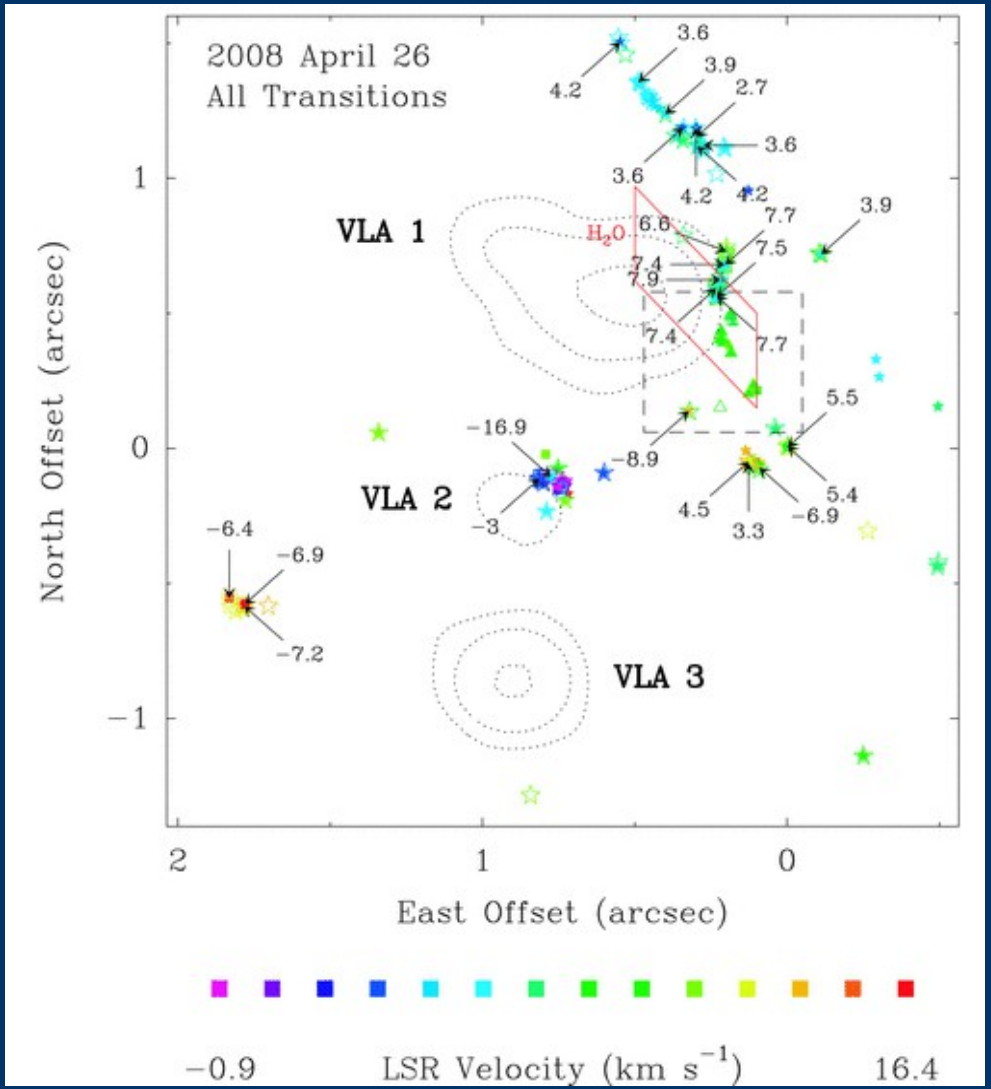
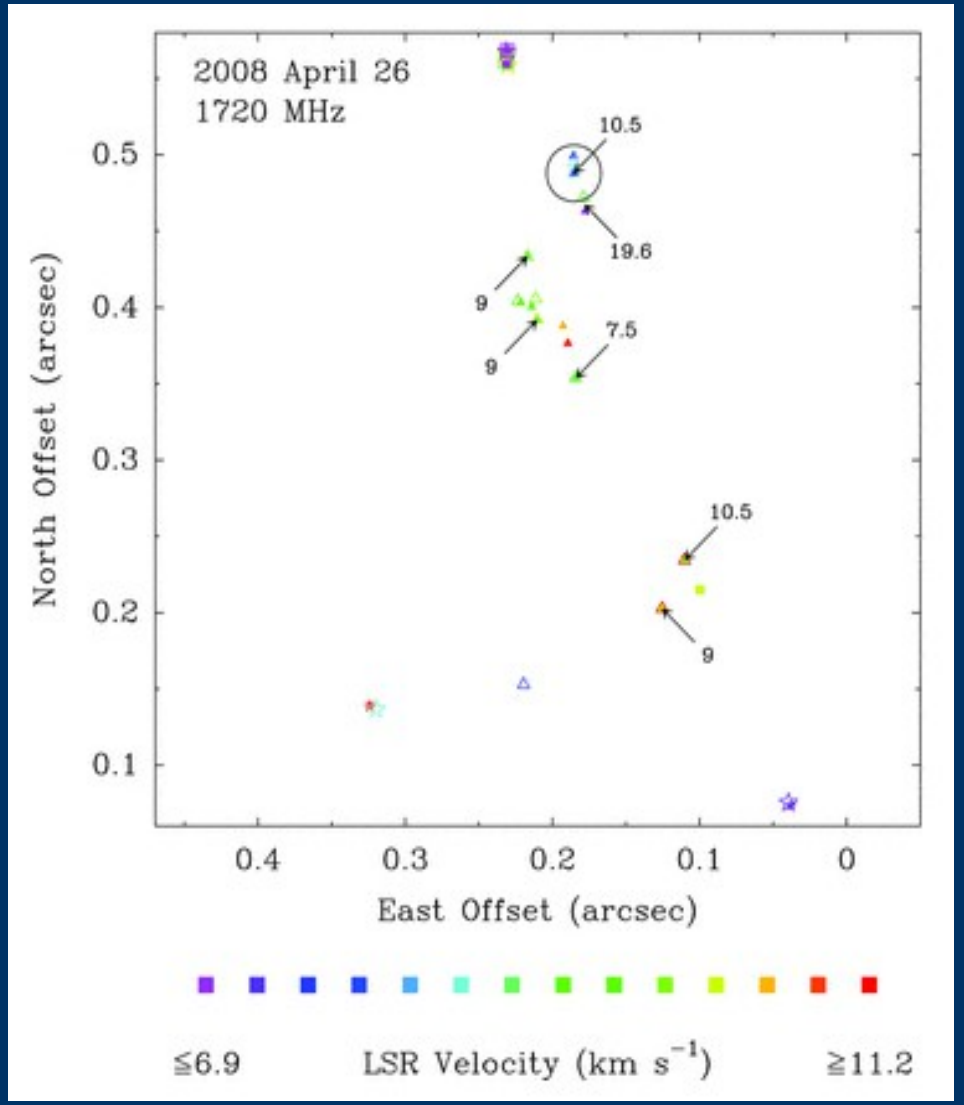
Rough Guide to Flares



- No precise definition
- Many types of variability
- Some periodic (P=26 to several x 100d)
- F(flare)/F(quiescent) = a few to apparently ∞
- May involve several species/transitions with (anti-)correlation

Locations in W75N





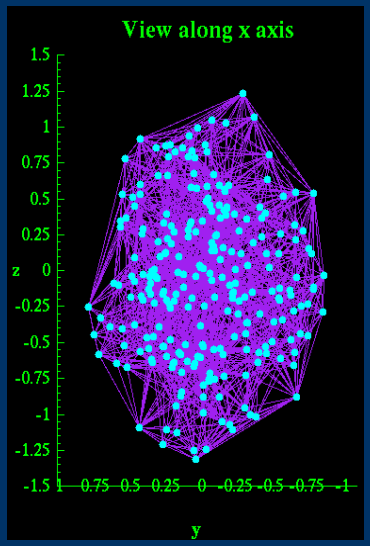
Conclusions for W75N

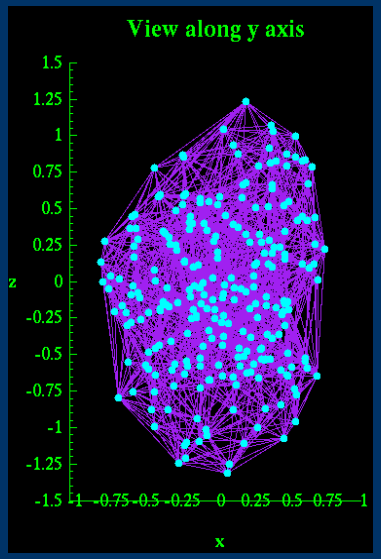
- Flaring in H2O and OH
- OH main lines and 1720MHz flares not coupled by shock (maybe by IR ~5 light days)
- 1720MHz flares more associated with H2O
- 1720 flare spots have large B (20mG)
- " " " " " proper motion
- F(flare)/F(quiescent) ~ 100 for 1720MHz OH and for H2O
- Not periodic; 1720-MHz decay time ~120d

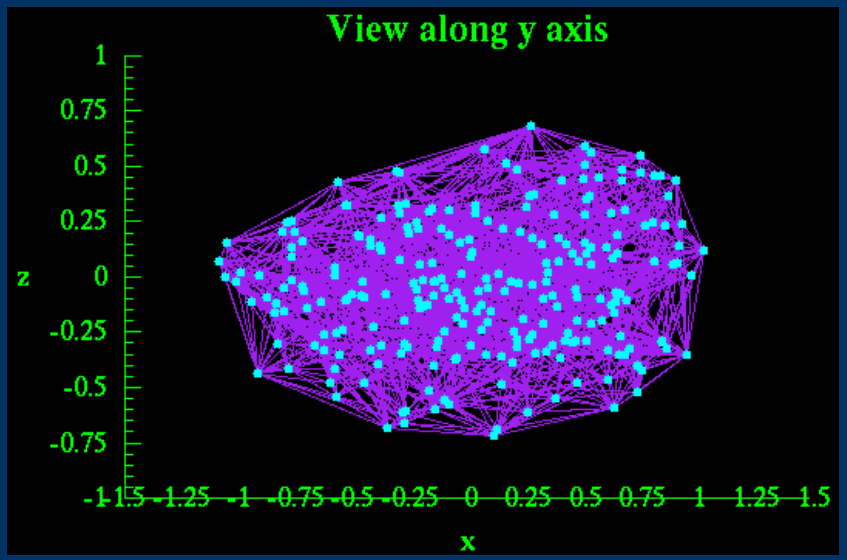
Investigation of Mechanisms

- Rotation of aspherical 'clouds'
- Superimposition of clouds in line of sight
- Variability in the seed radiation
- Variability in the pumping radiation
- Shock compression of a cloud (not yet)
- Others...please suggest!!

Overview of Model

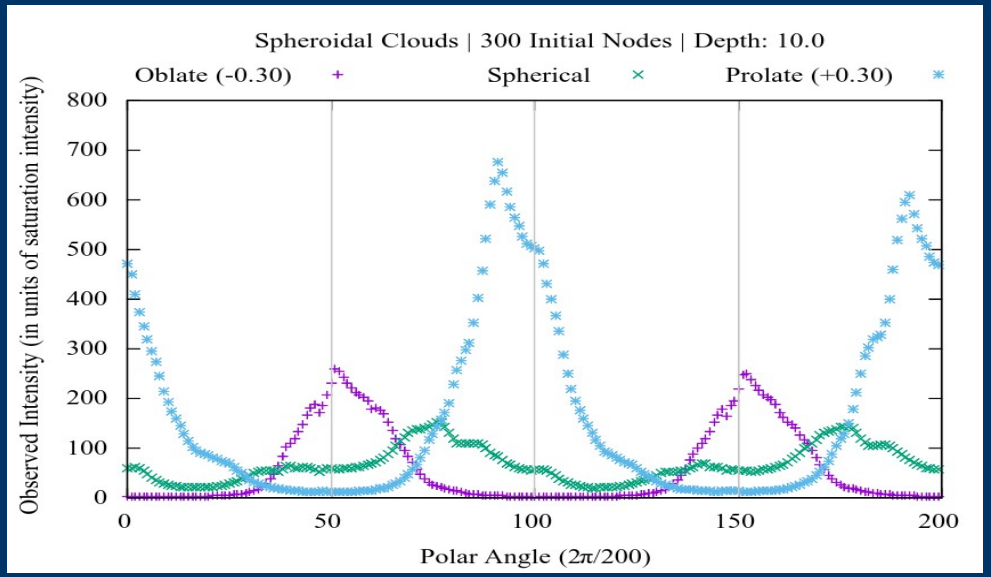


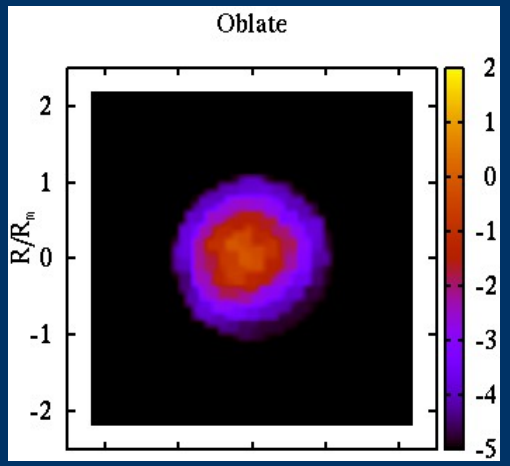


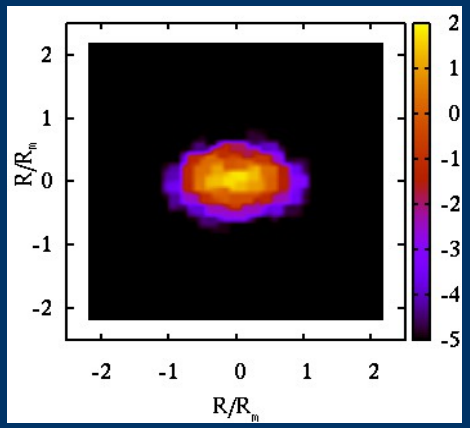


- Code fully 3D
- Includes saturation
- Uniform clouds (restriction removed)
- CVR
- Phenomenological pump
- Unpolarized (restriction removed)

Rotation of Spheroidal Clouds

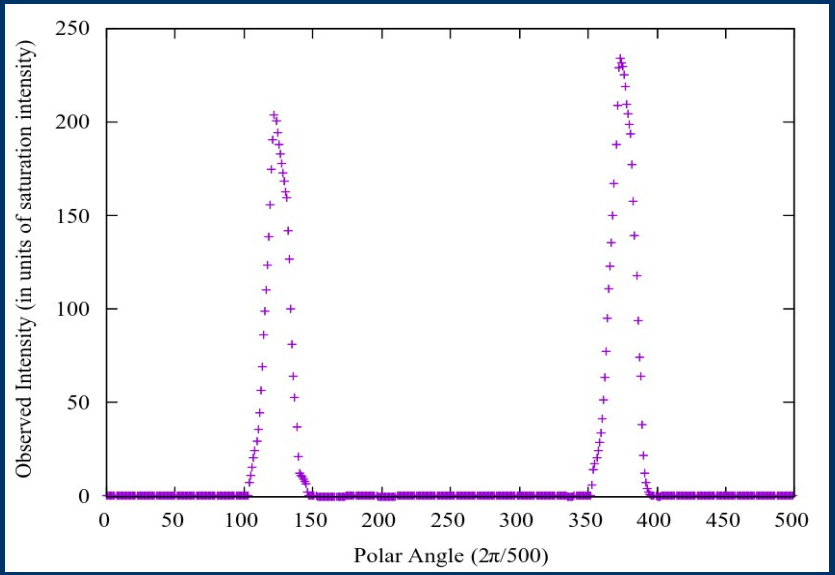


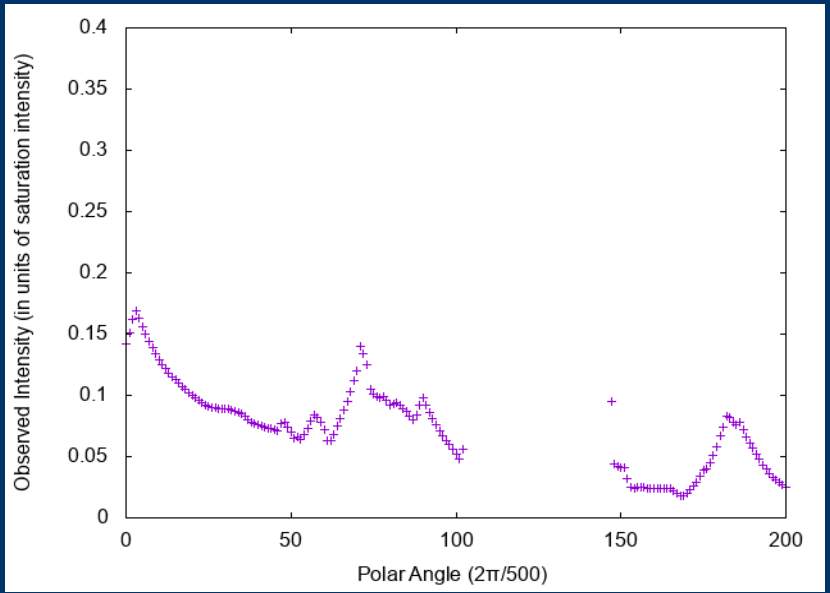




- Can get contrast of hundreds
- Duty cycle 0.2-0.5
- Contrast up, Dc down with increased saturation and/or more distorted cloud
- Periodicity unlikely (cloud stability)

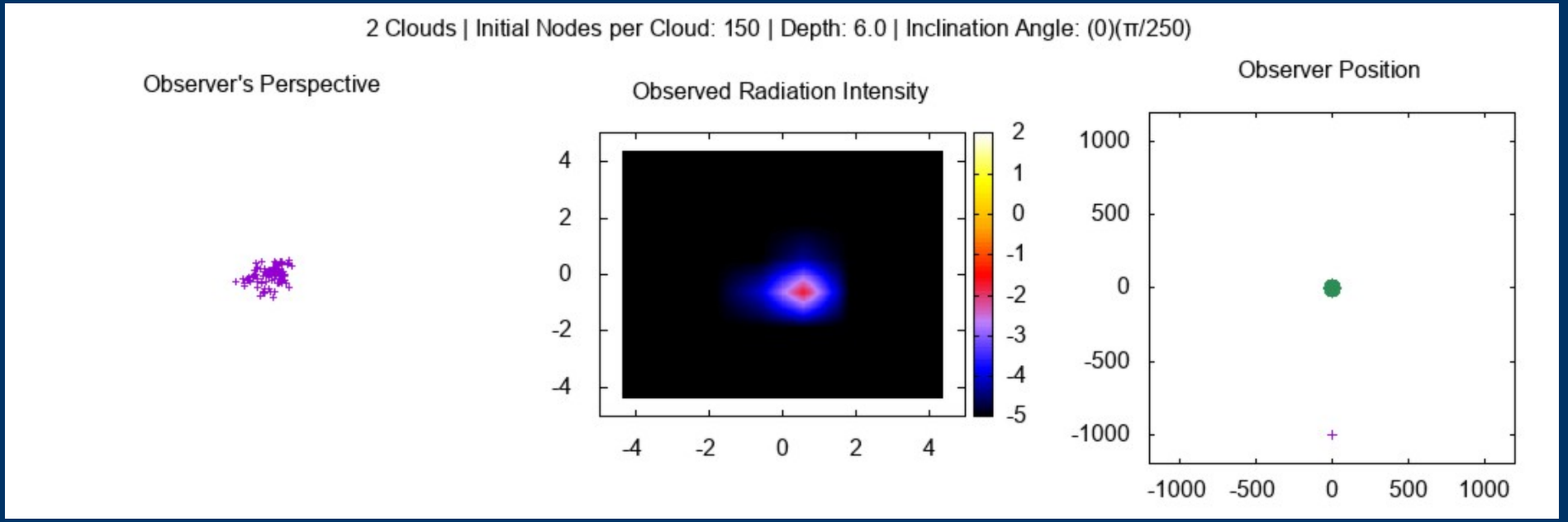
Superimposition



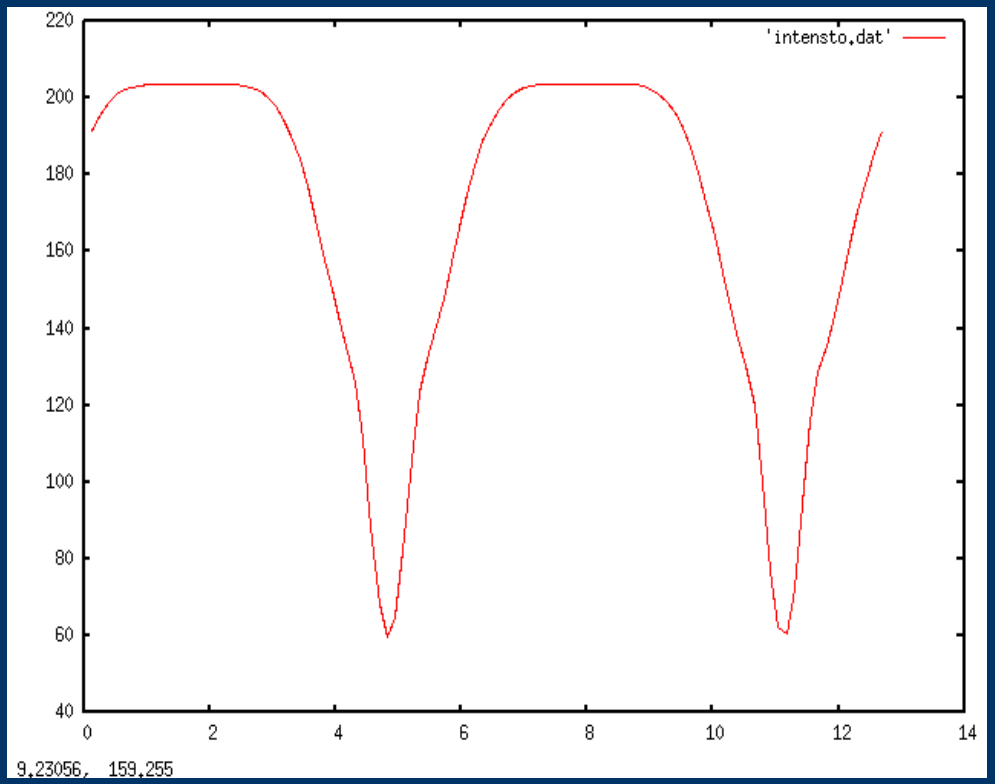


- Can get flare times of months for AU-scale clouds
- Duty cycle may be <0.1
- Easy to get flux ratio in thousands
- Real systems not periodic

Superimposition Movie

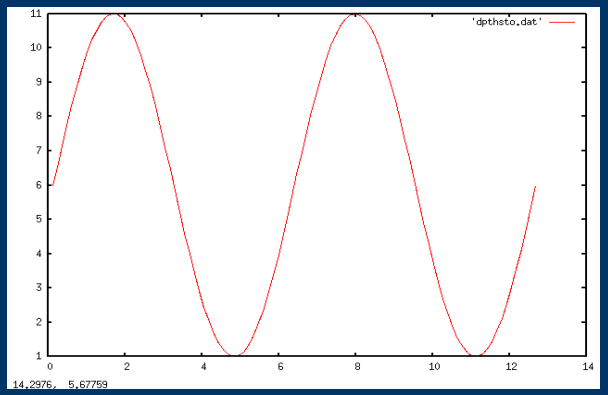


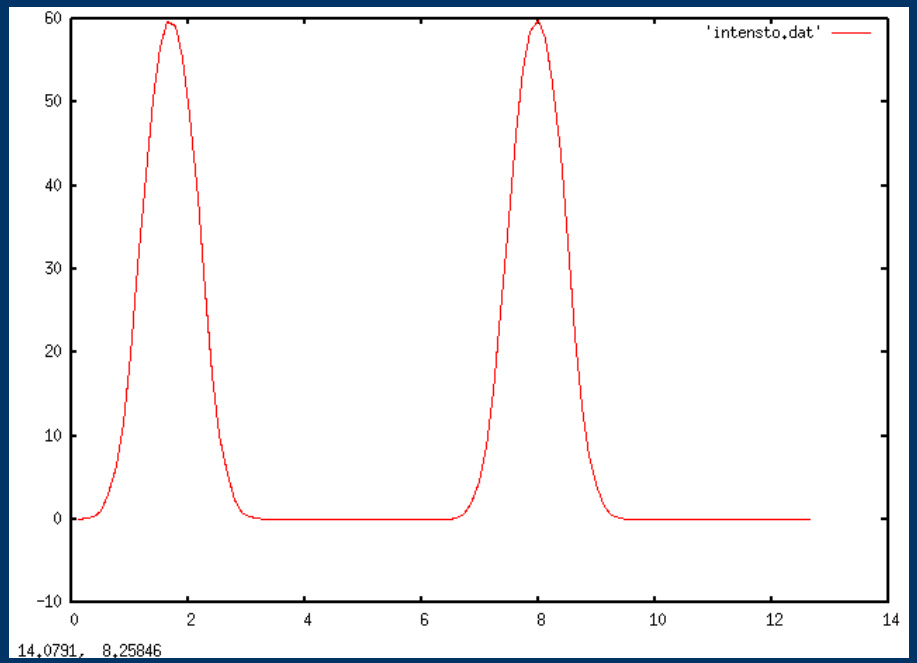
Variation of Seed Radiation



- Qualitatively different behaviour: high duty cycle
- Models similar when saturated, even for different backgrounds
- Candidates: G338.92-0.06 & G351.78-0.54 in Goedhart et al. '04
- Can be periodic

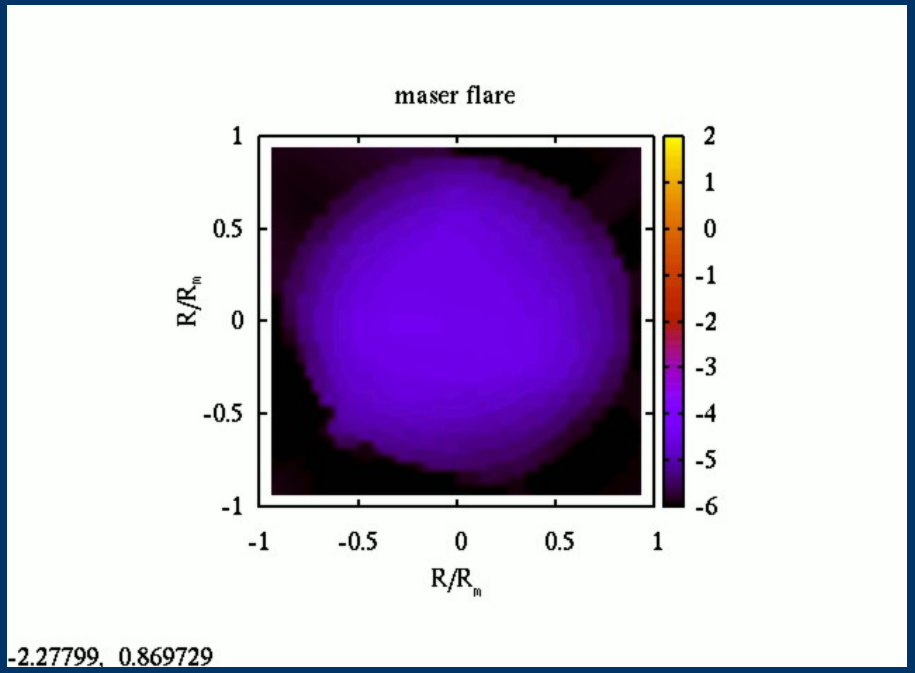
Variation of Pump

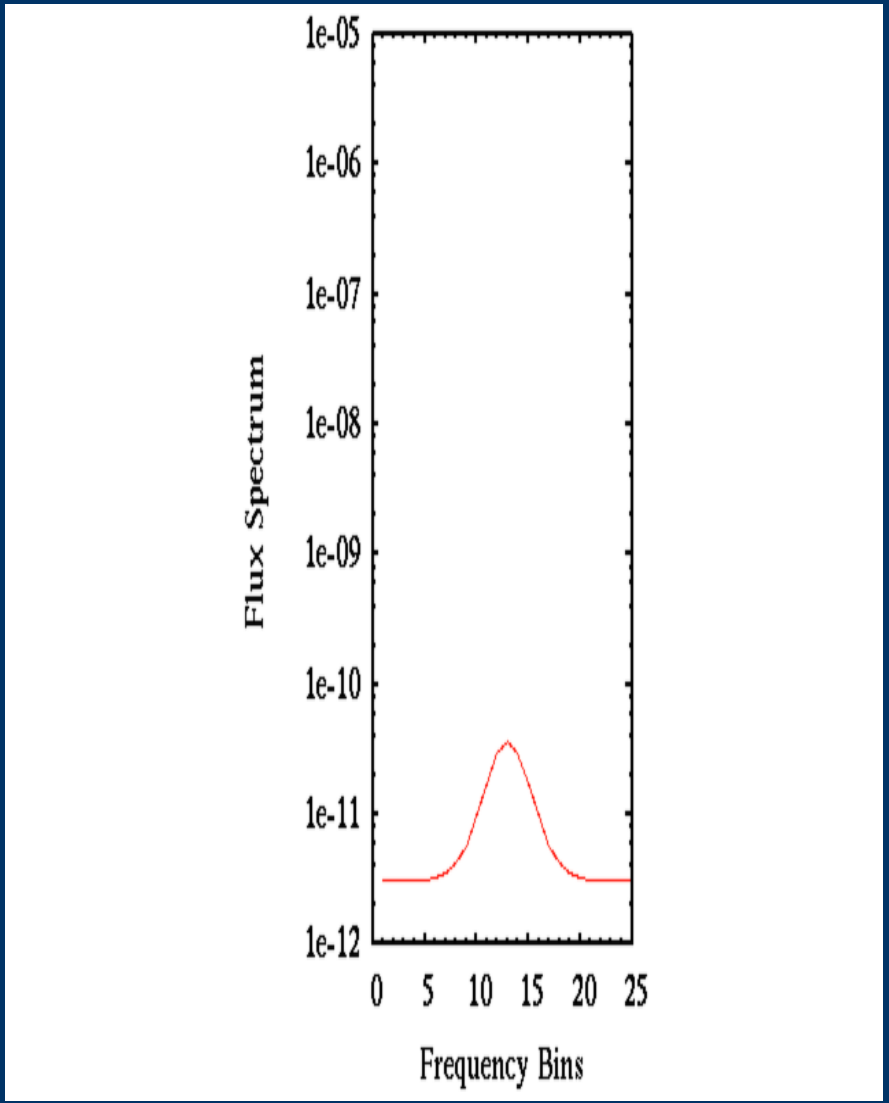




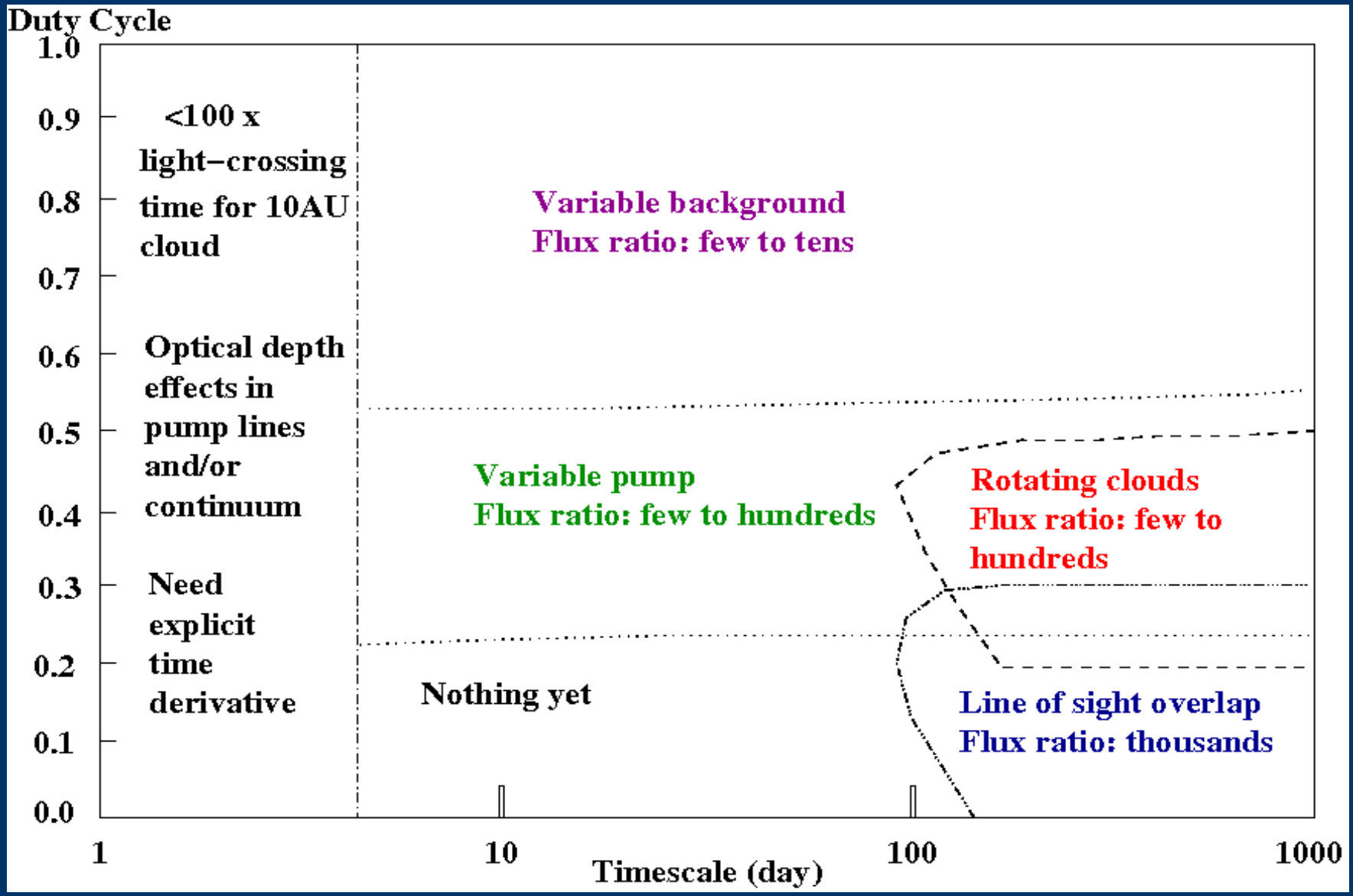
- Distinct flaring response to sinusoidal input
- Amplitude and duty cycle similar to rotation but shorter times scales available
- May be periodic
- Also tested sinusoid in log: more extreme

Pump Movies


maser flare
1
0.5
0
-0.5
-1
R/R_m
-1
-0.5
0
0.5
1
R/R_m
2
1
0
-1
-2
-3
-4
-5
-6
-2.27799, 0.869729


Flux Spectrum
1e-05
1e-06
1e-07
1e-08
1e-09
1e-10
1e-11
1e-12
0
5
10
15
20
25
Frequency Bins

Towards a Period/Duty Cycle Plot



Conclusions

- All the mechanisms tested can produce variability that is arguably 'flaring'.
- The most extreme flare to quiescent flux ratios come from line of sight superimposition
- As above for smallest duty cycles (at least if pump variation is ~sinusoidal)
- Variation of seed radiation causes a quantitavely different behaviour ('anti-flare')
- Shock compression flare to be done: needs hydrodynamic solutions.