Polarization rate variability in the SiO maser of chi Cygni

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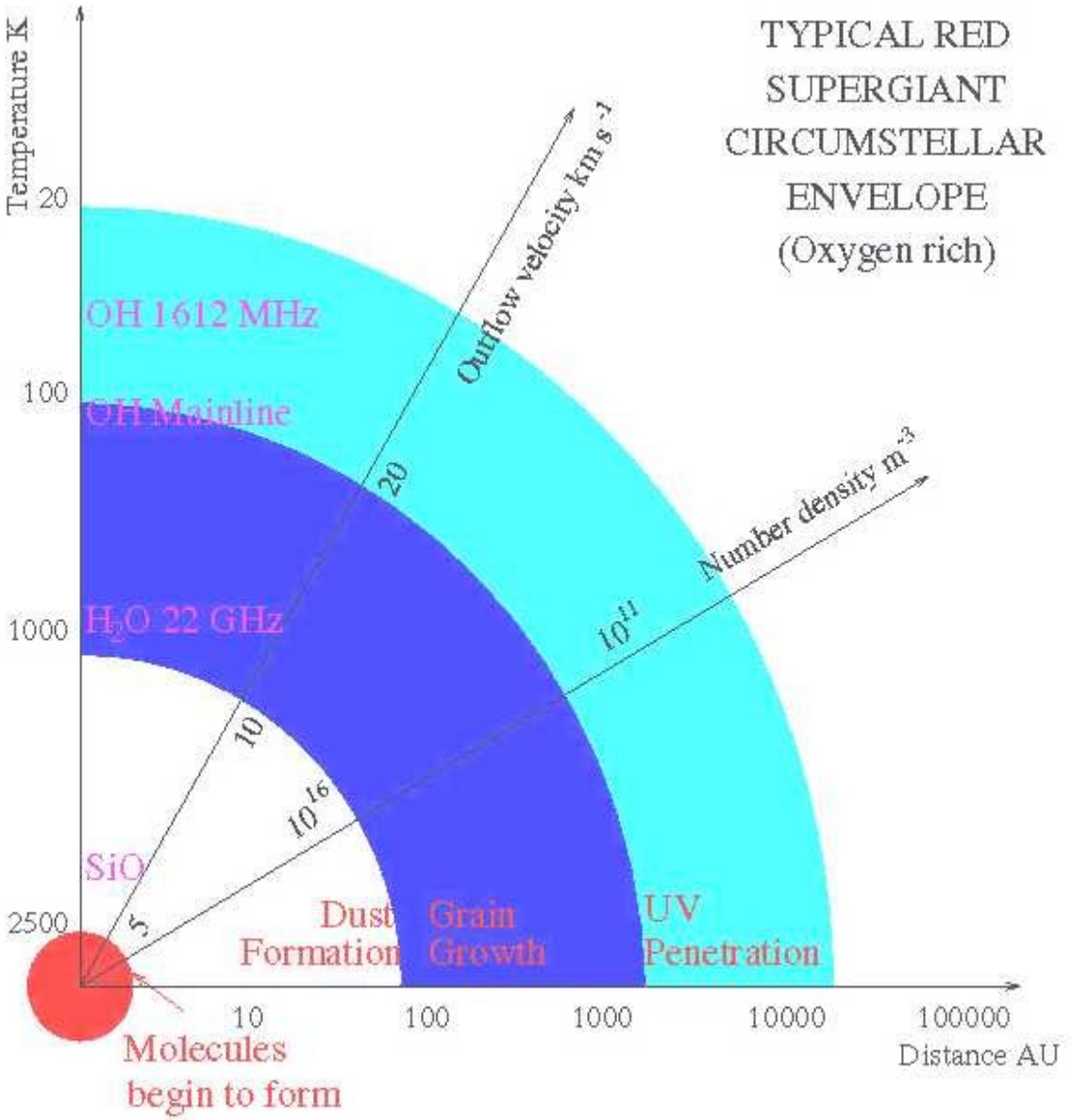
Motivations

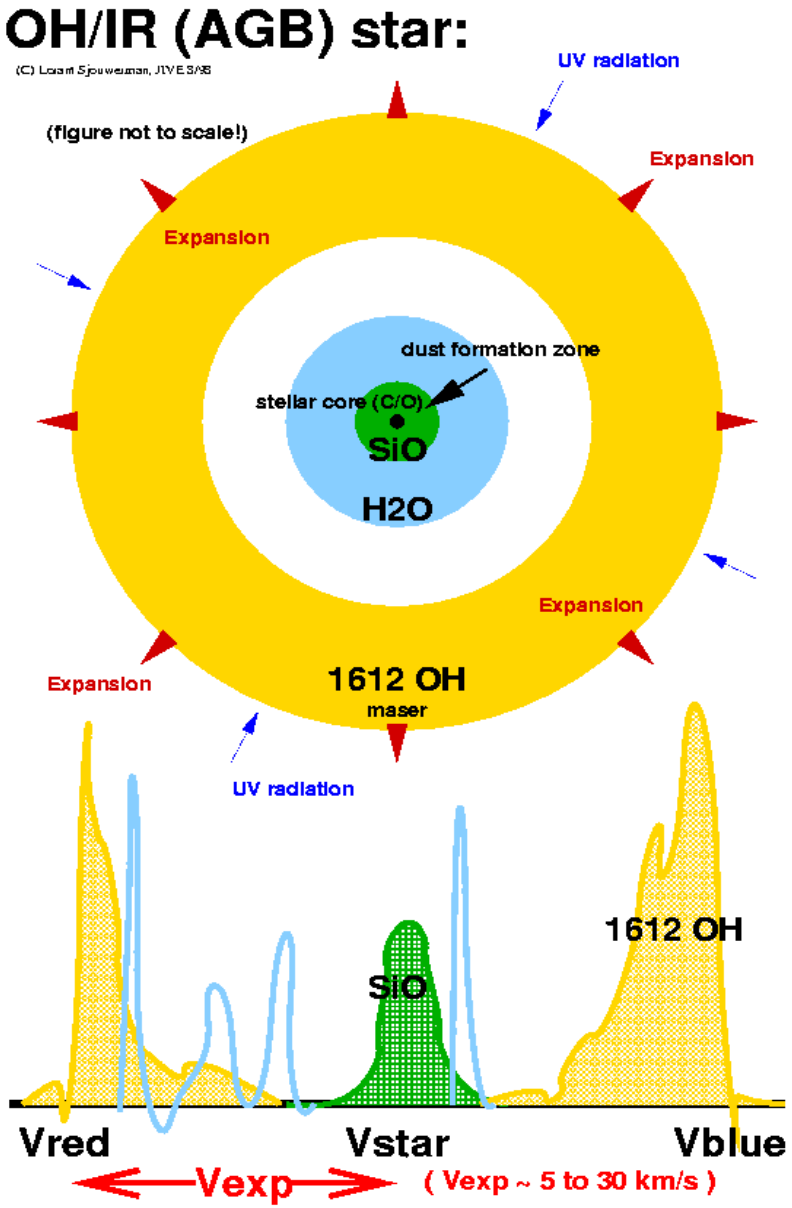
- SiO masers in evolved stars are know to be variable
- they show linear polarization and in a few cases also circular
- it is suggested that the polarization rate may vary on a short time scale (~1 hr)
  - the idea suffered from the lack of robust observational confirmation
- polarization studies can improve our understanding of circumstellar envelopes of evolved stars and the maser theory
  - comparison of the circular and linear polarization rate is essential to distinguish between the two proposed masing mechanisms of SiO
  - circular polarization is a tool to probe stellar magnetic fields

SiO masers in AGB stars



- SiO emission comes from the closest vicinity of the stellar photosphere (typically 5-10 AU from the star centre)
- SiO molecules are vibrationally excited
- on interferometer maps SiO masers appear as separate *spots*, often in a ring structure
- SiO masers in Mira variables exhibit high linear polarization (on average 30%) and weak circular polarization

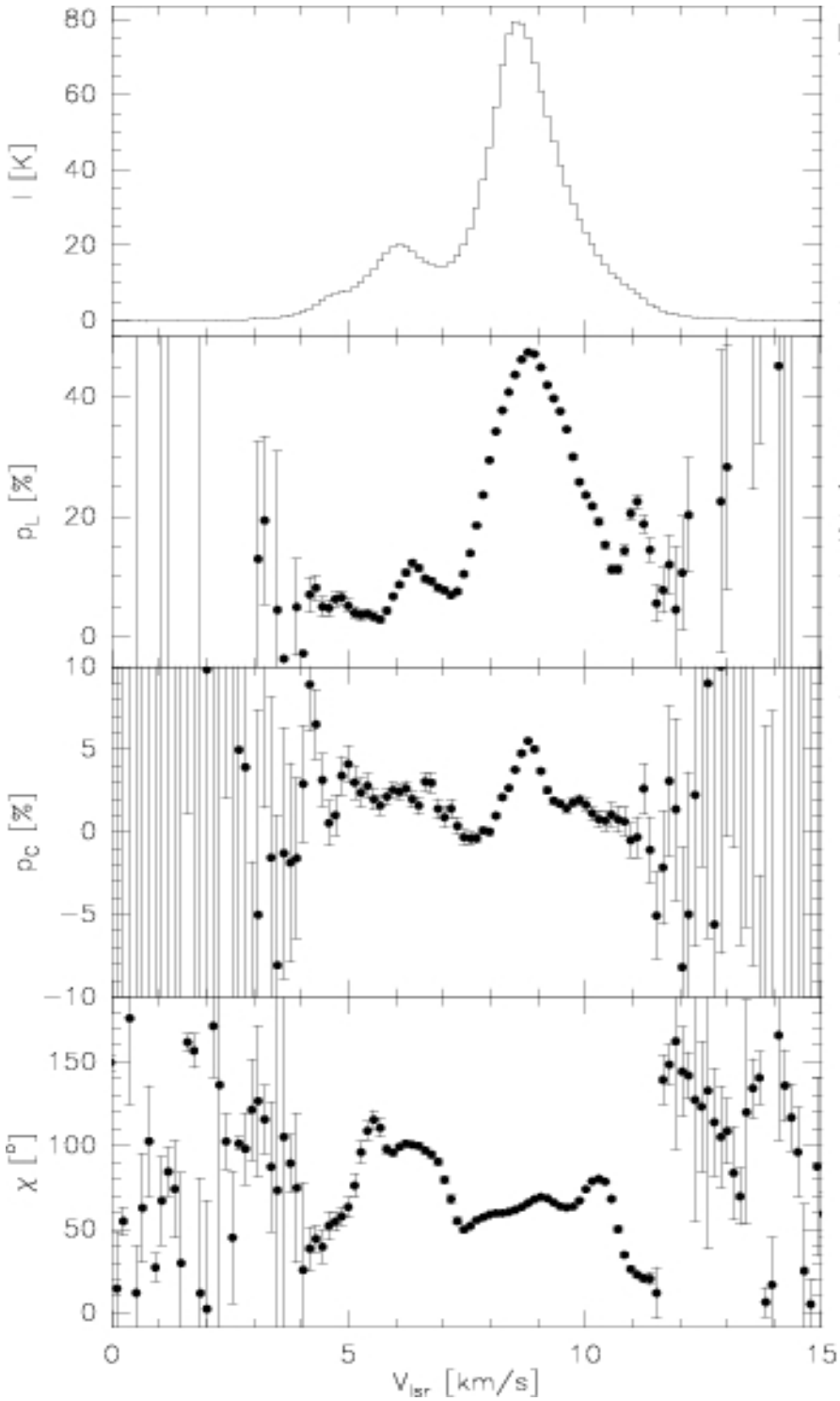
Mechanism of circular polarization



- When radiation propagates through a magnetized plasma the right-hand and left-hand polarization have different velocities and different attenuations.
- If the incoming radiation is linearly polarized it can be decomposed into two, circulary polarizated, waves.
- Due to the different velocities and attenuation the two waves are delayed with respect to each other, and we get a circular polarizated wave.

Our SiO sources

- monitoring of chi Cygni:
  - S-type star
  - Mira variable with a period of 402 days (AGB star)
  - distance = 110 pc
  - L = 5900 Lsun
  - dM/dt~10^{-7} Msun/yr
  - our polarimetric observation details:
    - 86.243 GHz, v=1 J=2-1
    - 1.5 min per scan
    - 25 observations
    - total time span of the monitoring: ~3 h
- snapshot observations of two M-type Miras:
  - T Cephei
  - S Ursae Minoris



Polarimeter: XPOL
Telescope: IRAM30m
Backend: VESPA

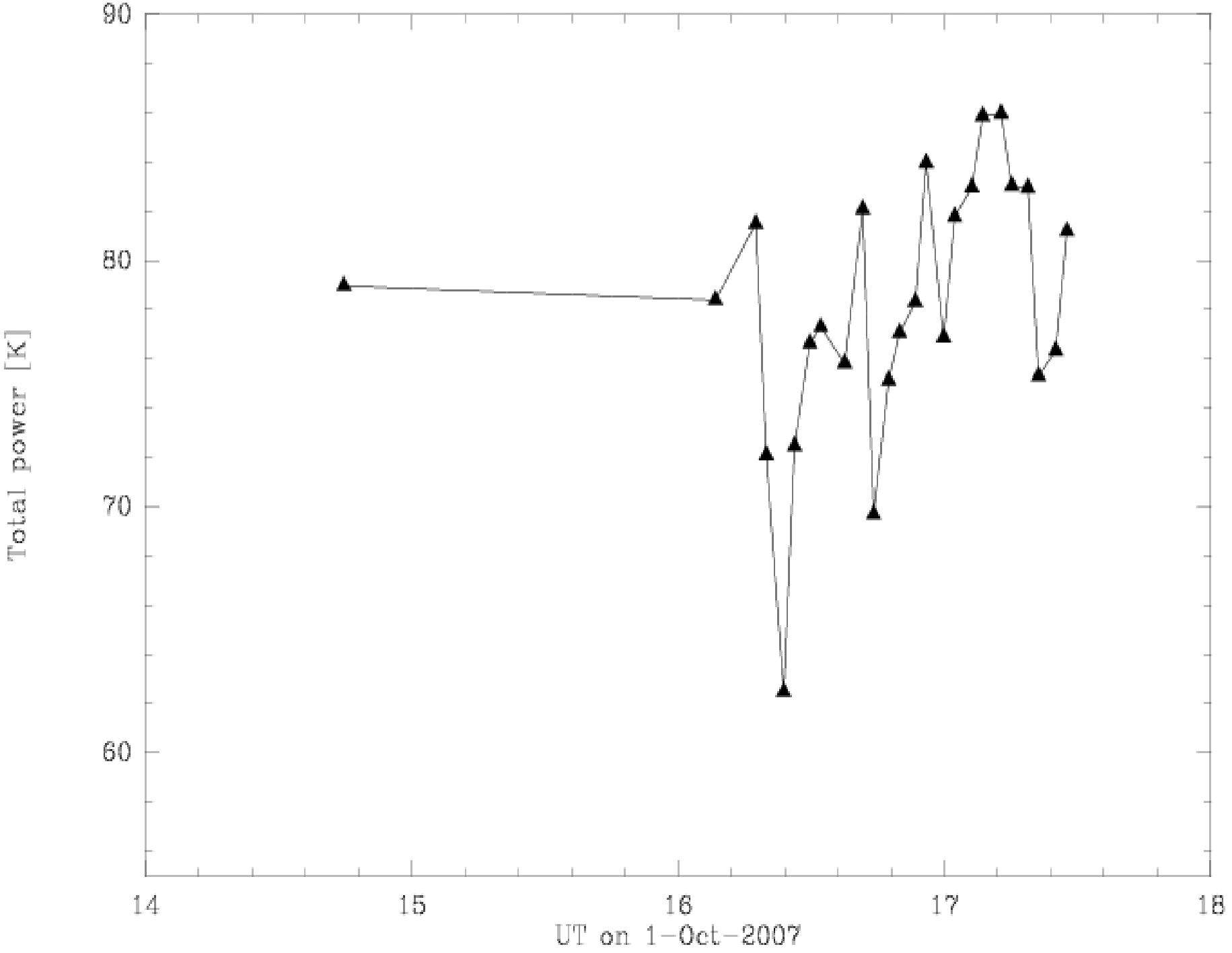
CHICYG
SIO(V1)

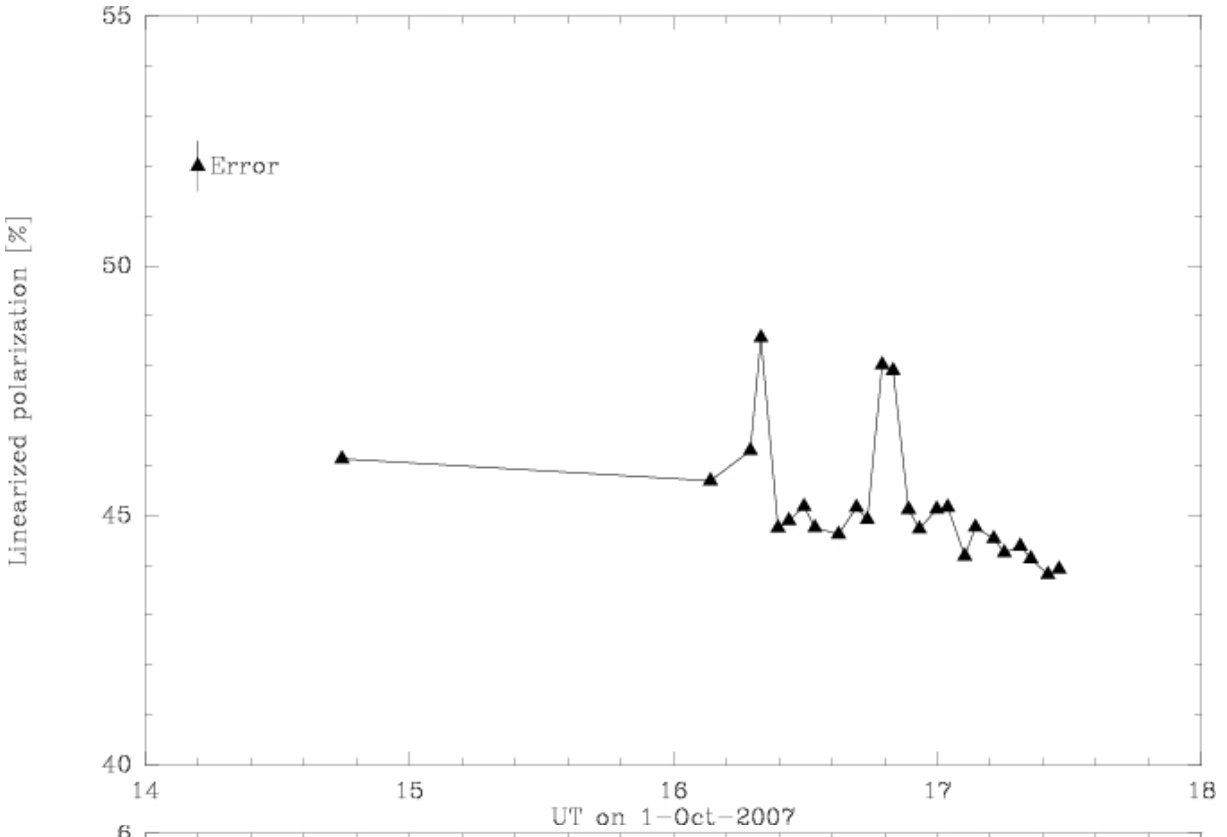
scan 103
4−OCT−2007
file: /home/group−a/xpol/st
XPOL version 4
UT: 14:44:44.27
LST: 15:10:57.77
HA: 15.183
ε = 33.9
η = −64.5
χ_0= 98.5
T_{sys} = 1 K
t_{int}= 1.5 min

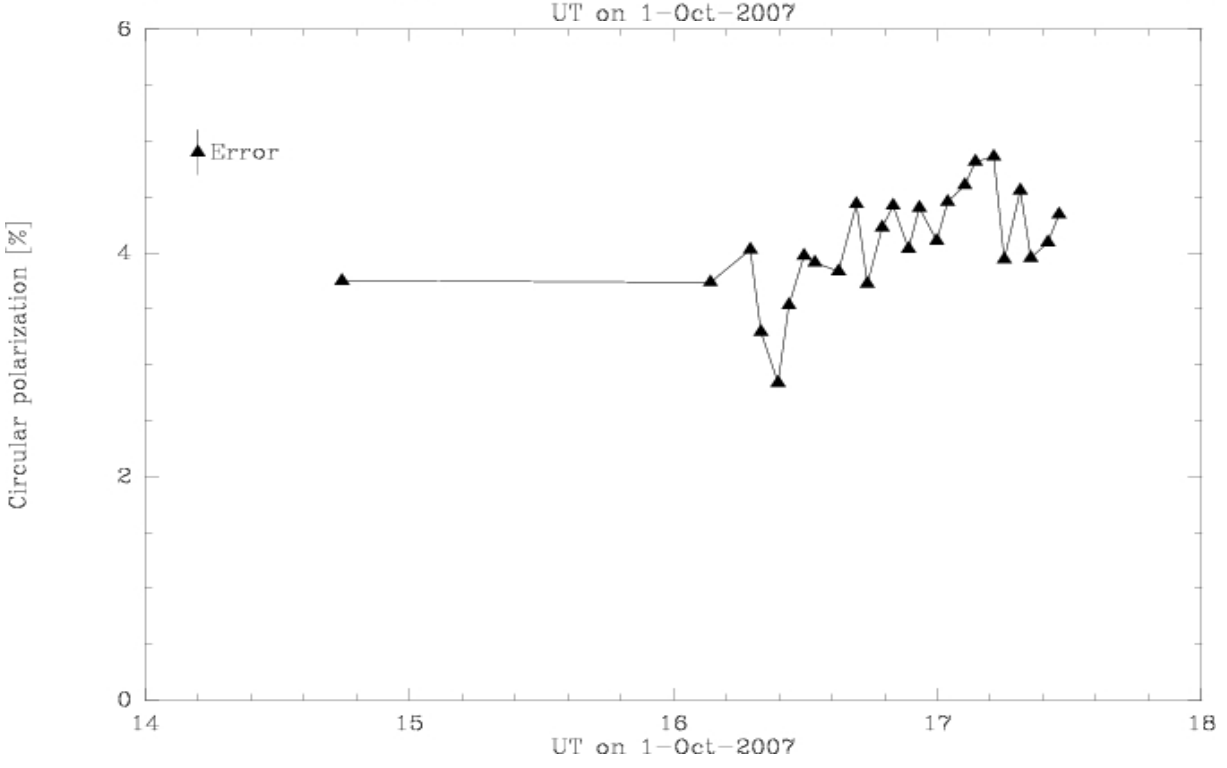
track: −1

equat. (Q,U)

G3AB not rotated


90
80
70
60
Total power [K]
14
15
16
17
18
UT on 1-Oct-2007


Error
Linearized polarization [%]
55
50
45
40
14
15
16
17
18
UT on 1-Oct-2007


Error
Circular polarization [%]
6
4
2
0
14
15
16
17
18
UT on 1-Oct-2007

Conclusion

- a strong maser in the envolope of chi Cygni was observed
- it shows strong linear polarization (45%) and an unusually high circular polarization (5%)
- the measurements show variability of circular and linear polarization in a short time scale (few hours)
- current instruments makes it possible to detect small scale variability in polarization
- more data (longer monitoring periods) are needed to make conclusive statements