

VERAユーザーズミーティング2007

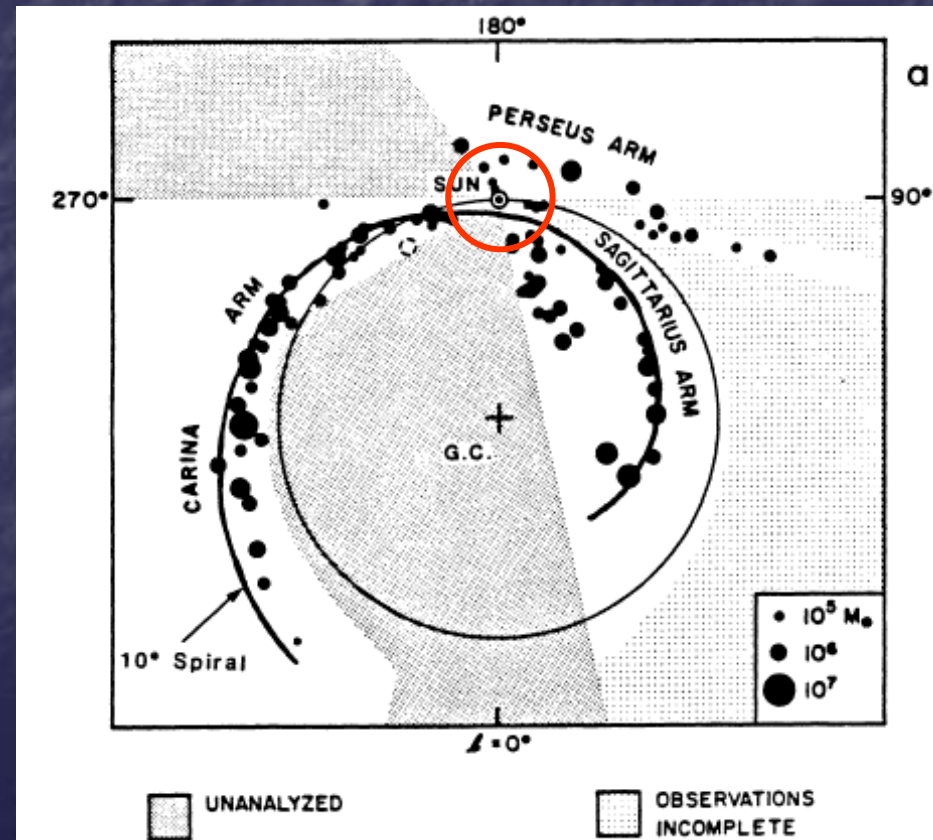
プロジェクト観測結果報告
近距離分子雲の距離決定

Tomoya HIROTA (VERA, NAOJ)

Nearby SFRs project

- H₂O masers in SFRs within 1 kpc from the Sun
- One of the initial projects (since 2004 January)
- Aim of this project
 - Distance measurements
 - 3-D structure of molecular clouds
 - Refine the physics of star-formation

Distribution of molecular clouds
(Grabelsky et al. 1988)

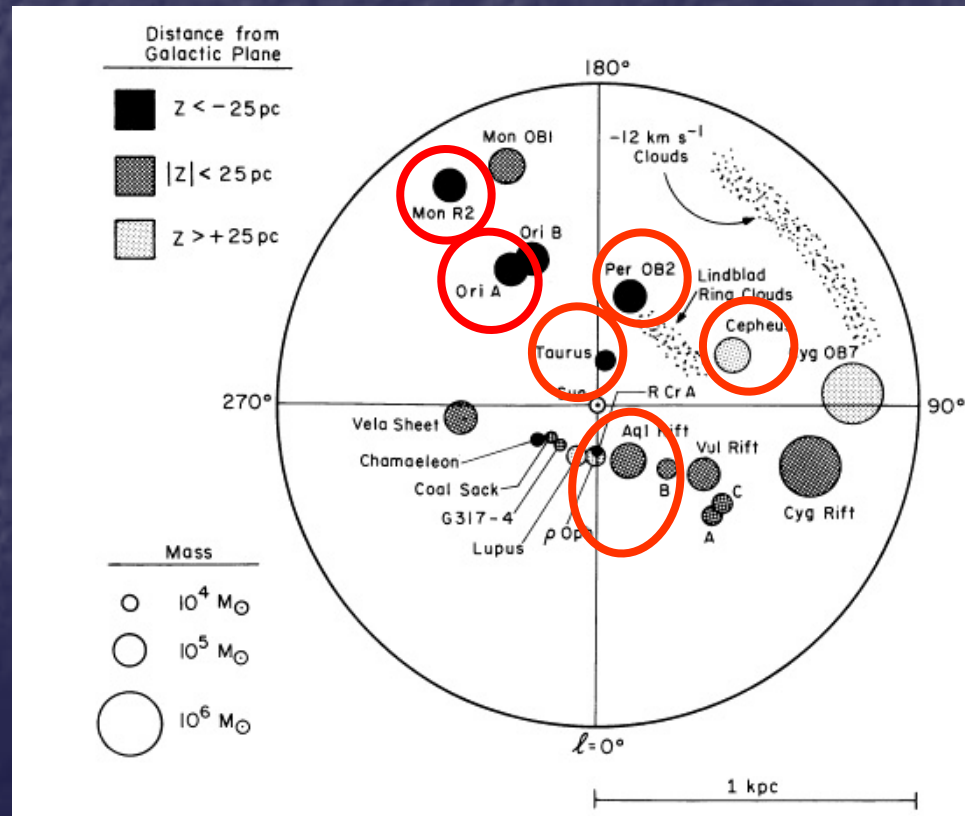


Nearby SFRs project

- H₂O masers in SFRs within 1 kpc from the Sun
 - Orion-Monoceros Molecular Cloud complex (Orion KL etc.)
 - Taurus (TMR-1)
 - Perseus (NGC1333)
 - Ophiuchus (IRAS 16293)
 - **Serpens (Serp. SMM-1)***
 - **Cepheus (L1204A)***

*Since Nov. 2006

Distribution of molecular clouds (Dame et al. 1987)



After the UM2006

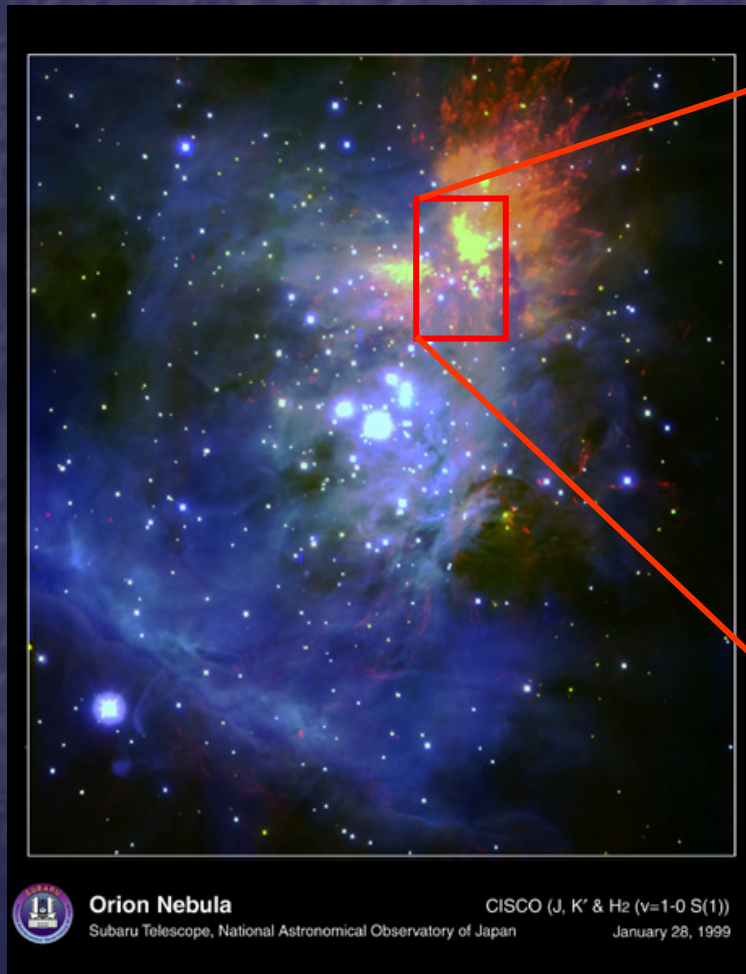
■ Publications

- Orion KL (H₂O maser; Hirota et al. 2007, PASJ, 59, 897)
- IRAS 16293-2422 (Imai et al. 2007, PASJ, 59, in press)
- NGC1333 (Hirota et al. 2008, PASJ, 60, in press)

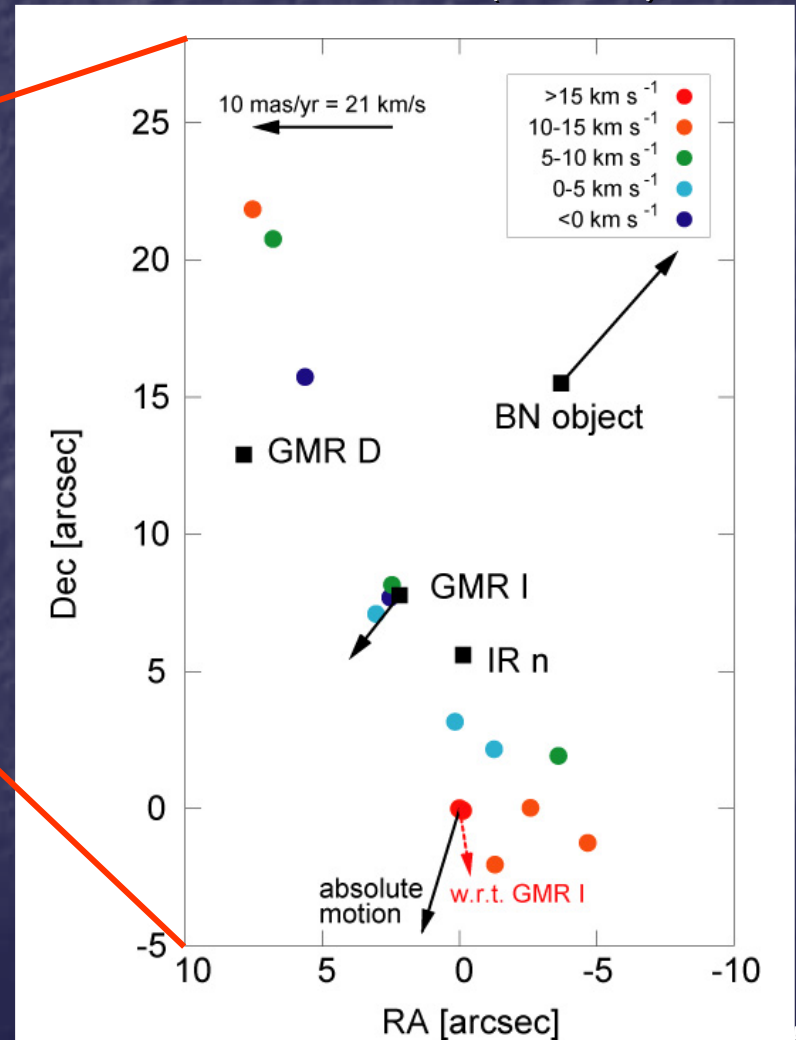
- Orion KL (SiO maser; Kim et al. 2008, in preparation)

H2O masers in Orion KL

NIR image (Subaru)



H2O masers (VERA)

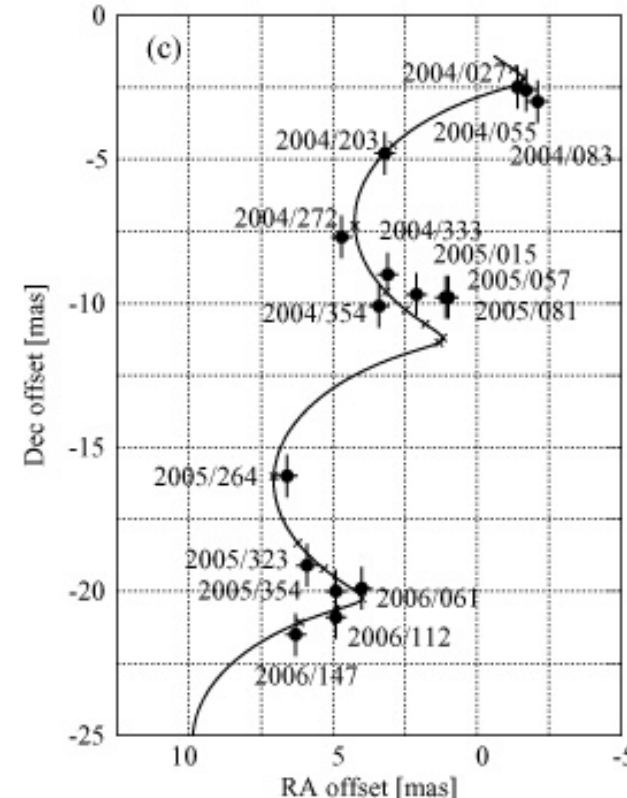
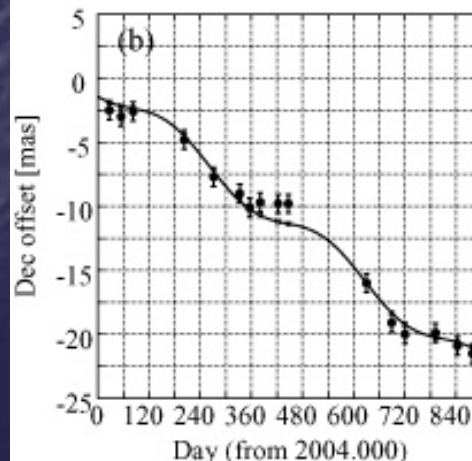
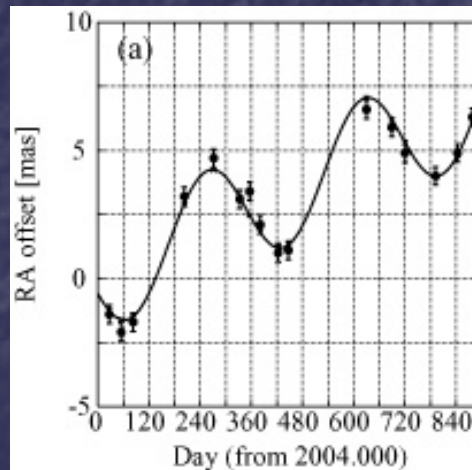


H2O masers in Orion KL

- Hirota et al. 2007, PASJ, 59, 897

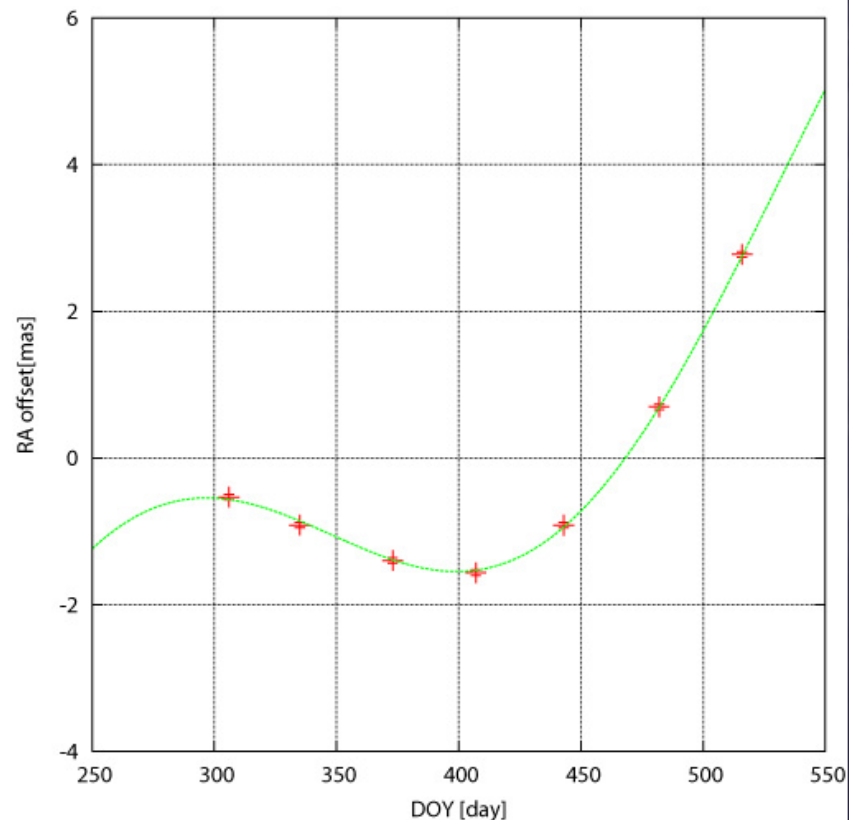
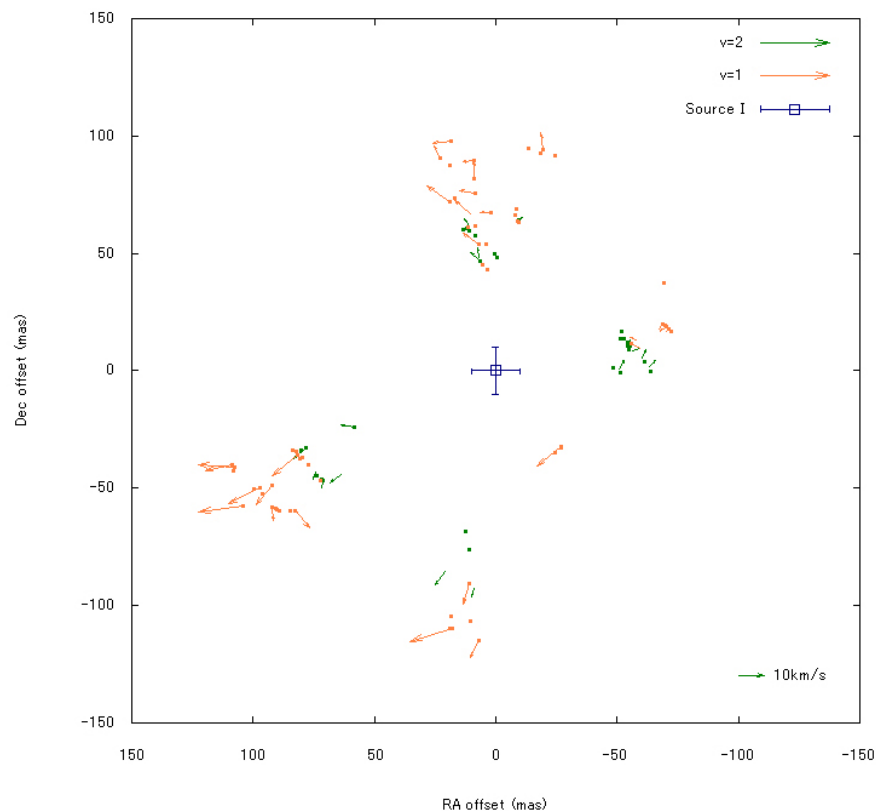
- 2.29 ± 0.10 mas
= 437 ± 19 pc

- Well known value:
 480 ± 80 pc
(Genzel et al. 1981)



SiO masers in Orion KL

- Kim et al. 2008, in preparation
 - 2.39 ± 0.06 mas = 419 ± 6 pc



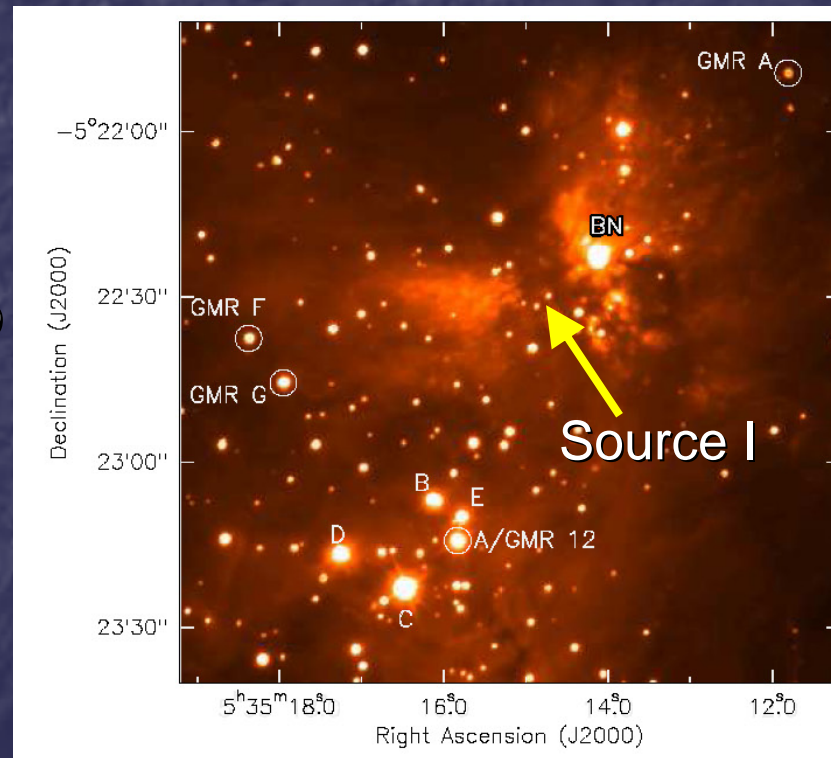
Other researches for Orion

■ Radio continuum source in Orion Nebula Cluster

- GMR-A: **389 +24/-21 pc**
(VLBA 15 GHz: Sandstrom et al. 2007, ApJ, 667, 1161)
- Average of 4 non-thermal radio sources in ONC: **414+/-7 pc**
(VLBA 8 GHz: Menten et al. 2007, A&A, in press)

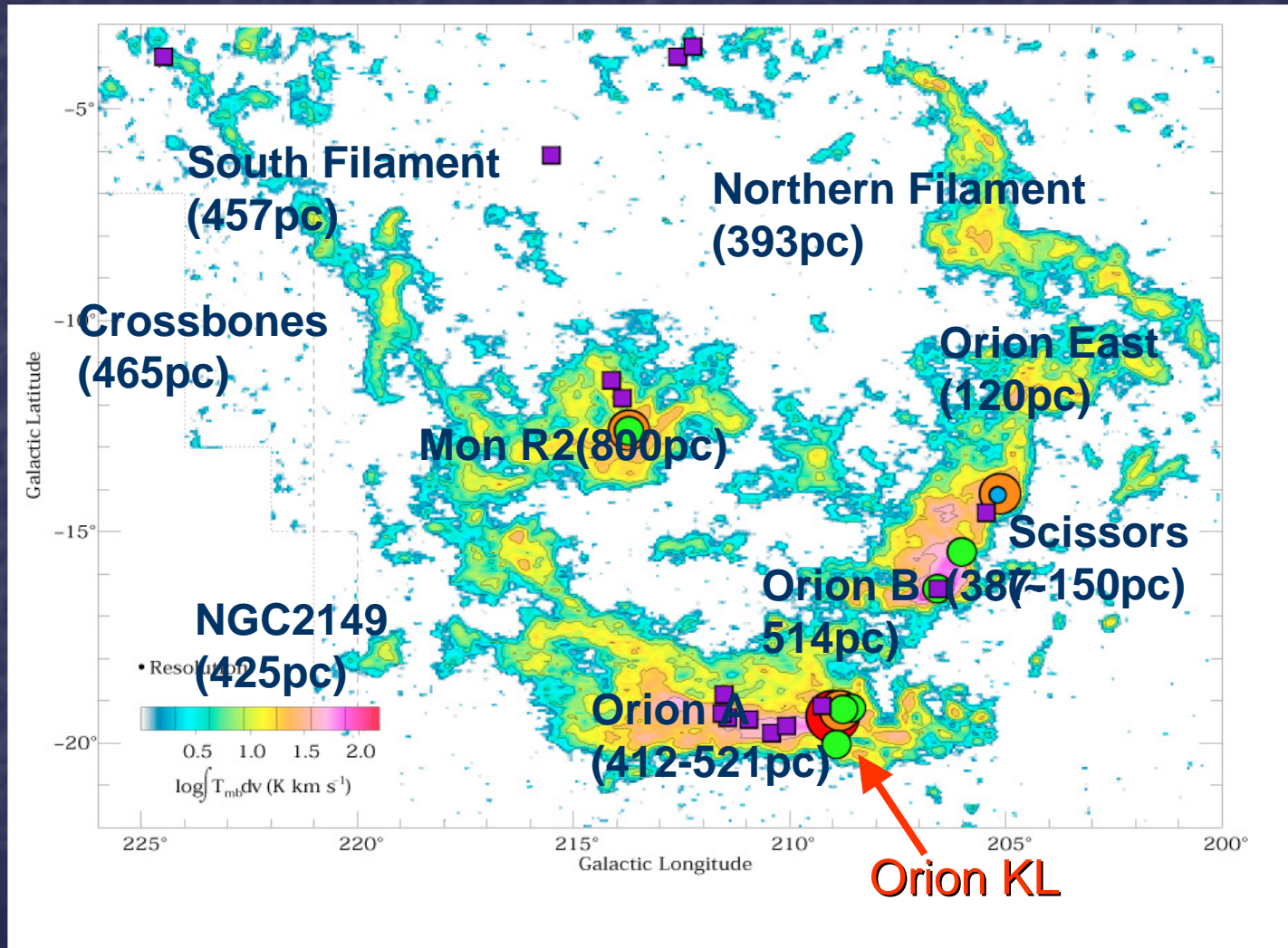
■ SiO masers in Orion KL

- **419+/-6 pc** (VERA: Kim et al. 2008, in preparation)



Position of radio sources
(Menten et al. 2007)

Orion-Monoceros complex

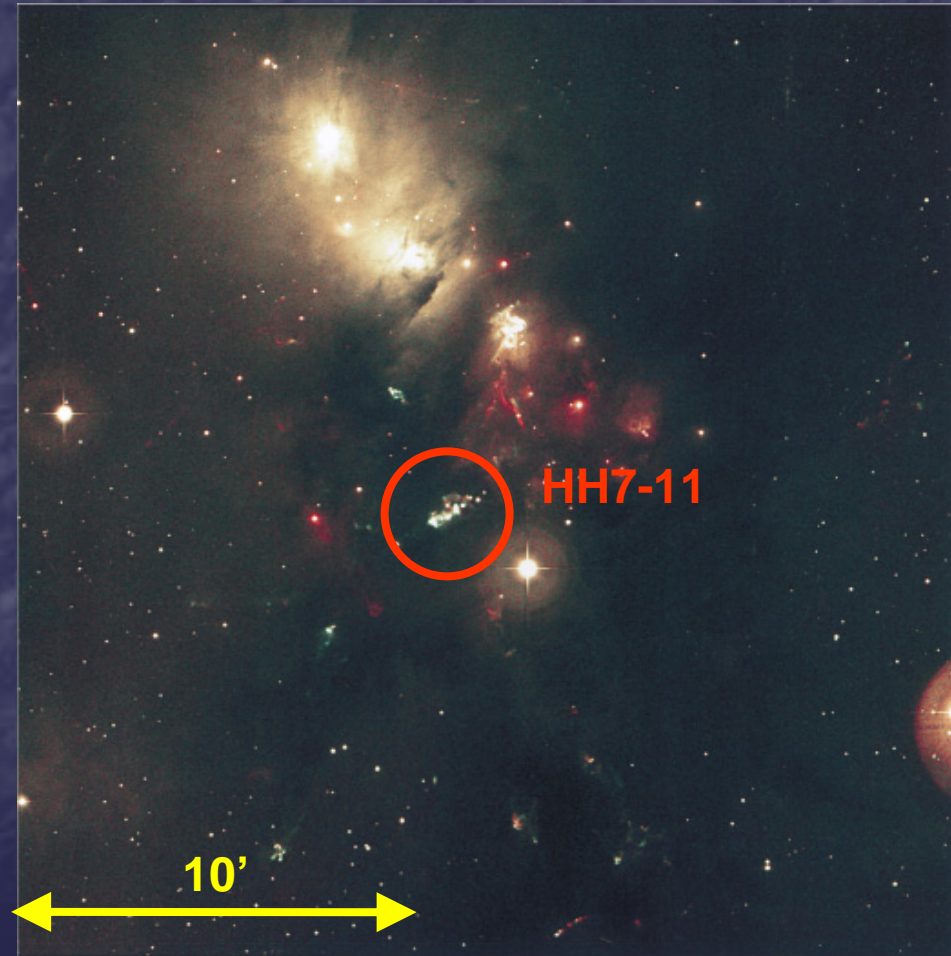


Distribution of molecular clouds (Wilson et al. 2005)

NGC1333

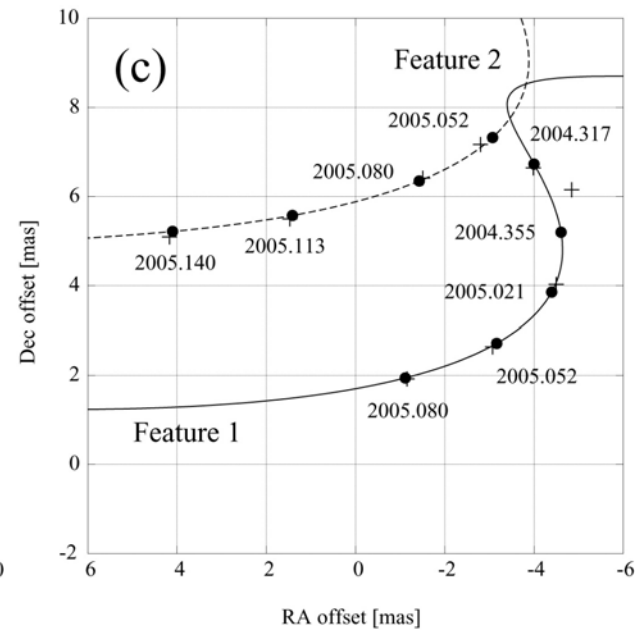
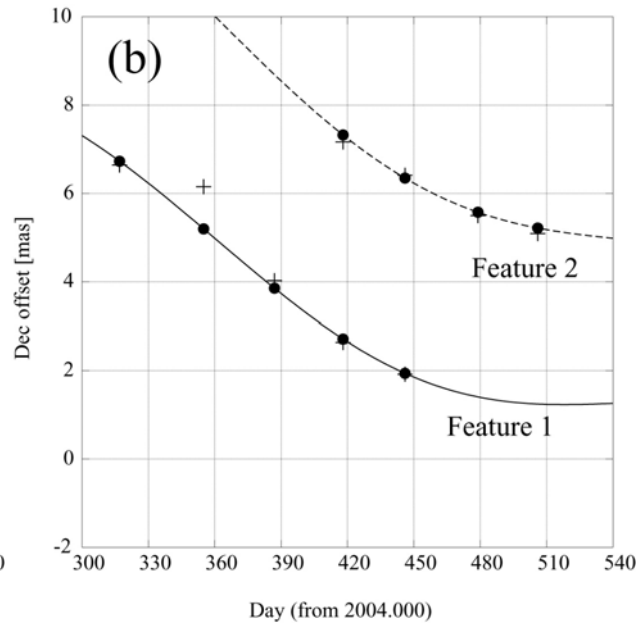
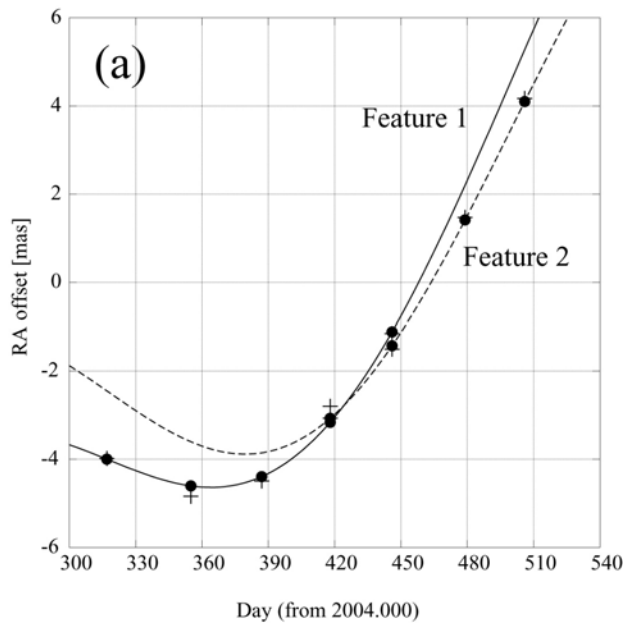
- Nearby low-mass SFR
 - Cernis (1989):
extinction --- 220 pc
 - de Zeeuw et al. (1999):
HIPPARCOS (Per OB)
--- 318+/-27 pc
- Cluster of YSOs
- Numbers of HH flows

SII and HI image
(Bally et al. 1996)



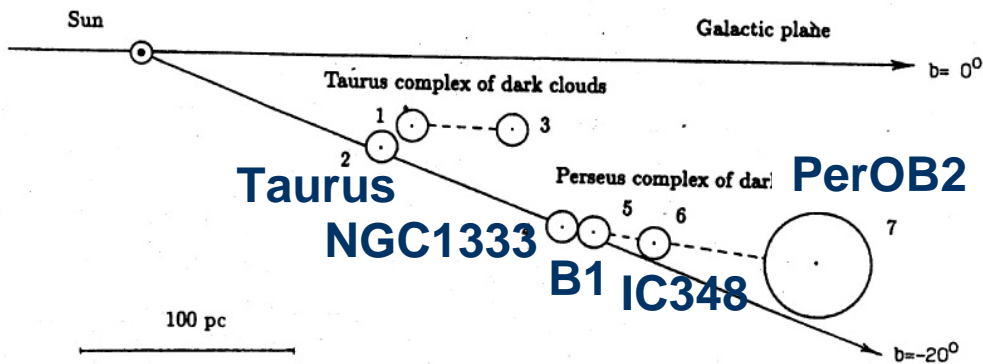
H2O masers in NGC1333

- Hirota et al. 2008, PASJ, in press
 - $4.25 \pm 0.32 \text{ mas} = 235 \pm 18 \text{ pc}$

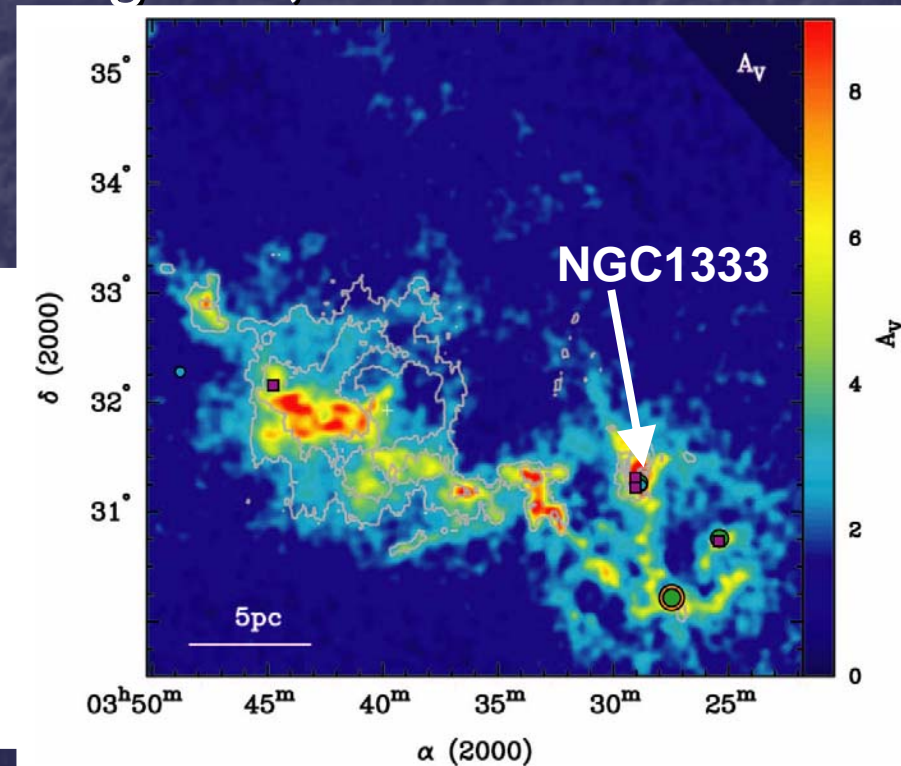


Perseus complex

- Nearest cluster forming region
- Chain of dark clouds and HII regions, and OB clusters
 - 3D structure of clouds?
 - Relationship between Taurus and Perseus?



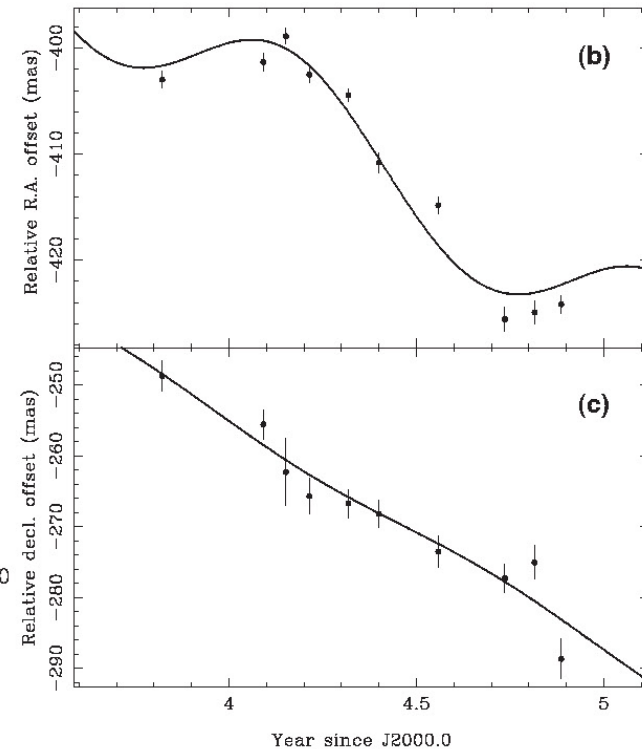
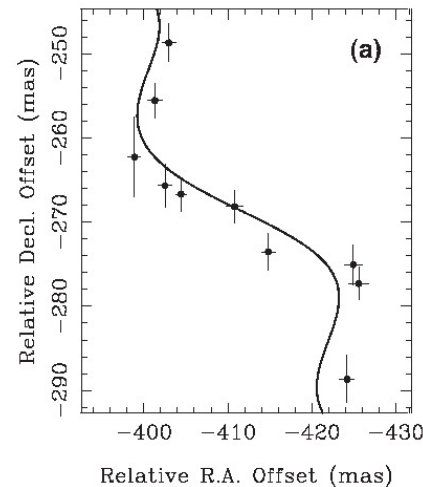
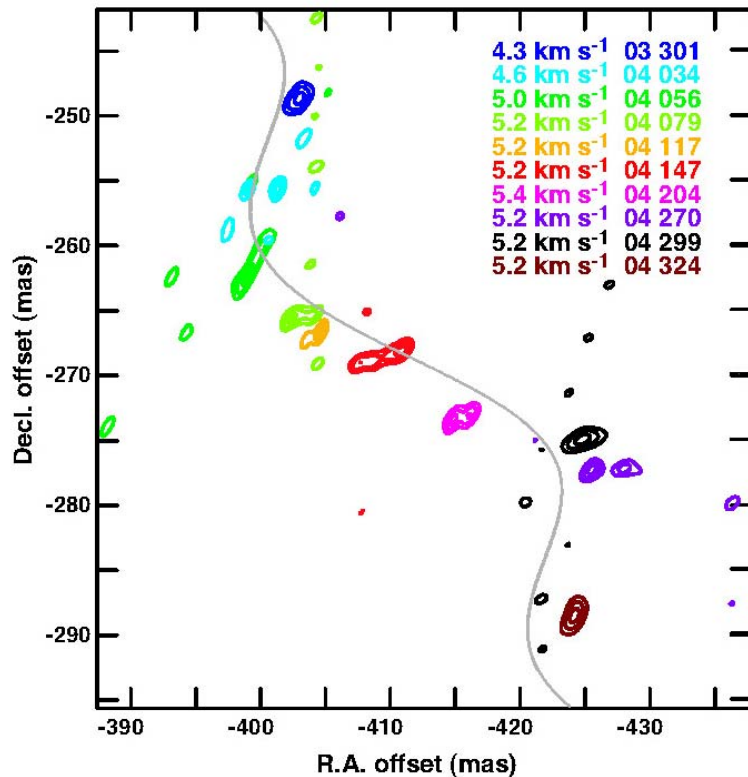
Distance to dark clouds (Cernis 1993)



Distribution of molecular clouds
= A_V map (Ridge et al. 2006)¹²

H2O masers in IRAS 16293-2422

- Imai et al. 2007, PASJ, 59, in press
 - $5.6 \pm 1.5 / -0.5 \text{ mas} = 178 \pm 18 / -37 \text{ pc}$



Other researches

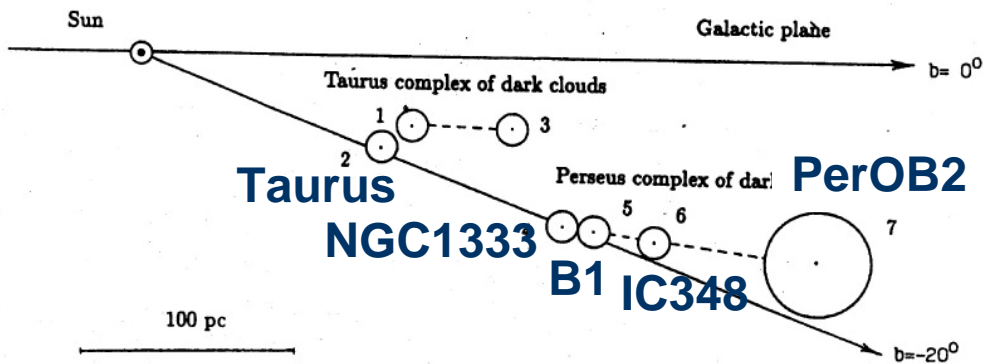
- Radio continuum sources in Taurus (VLBA 8 GHz)
 - T-Tau Sb: **147.6 +/- 0.6 pc** (Loinard et al. 2007)
 - Hubble 4: **132.8 +/- 0.5 pc** (Torres et al. 2007)
 - HDE283572: **128.5 +/- 0.6 pc** (Torres et al. 2007)
 - Distance and depth of Taurus Molecular Cloud:
137 +/- 20 pc
- Radio continuum sources in Ophiuchus
 - Distance of Ophiuchus Molecular Clouds:
~120 and ~160 pc (Loinard et al. 2007, in IAUS248)

Next season

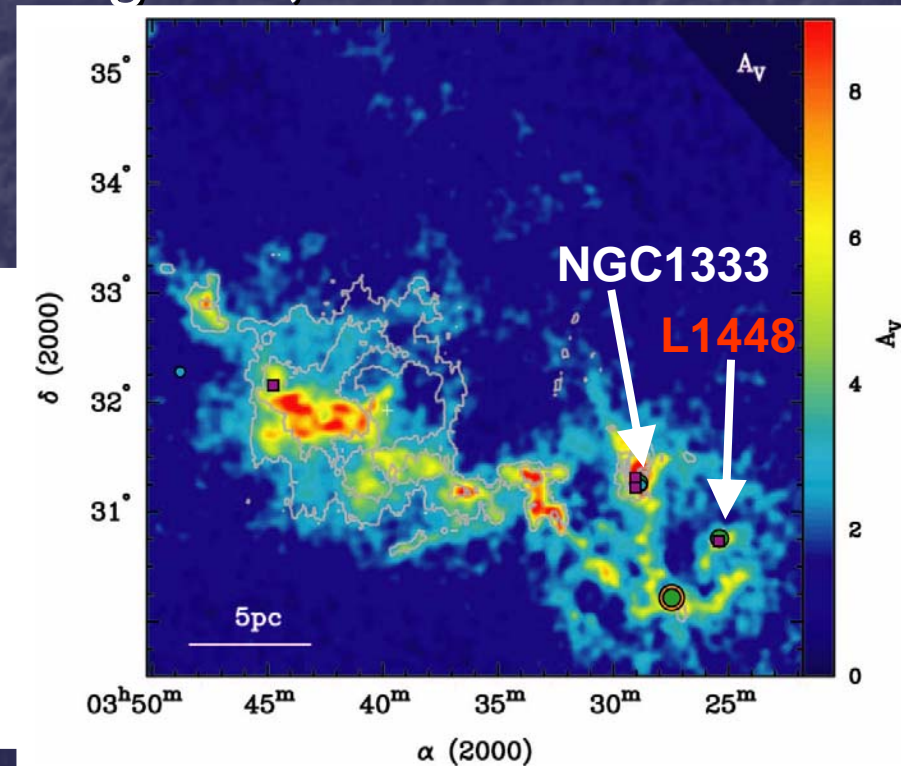
- Continue observations of
 - L1204A in Cepheus
 - TMR-1 in Taurus (if possible)
 - Serpens SMM-1 in Serpens (if possible)
- New observations of
 - L1448C in Perseus
 - Several sources in Orion and/or other regions (TBD)

Perseus complex

- Nearest cluster forming region
- Chain of dark clouds and HII regions, and OB clusters
 - 3D structure of clouds?
 - Relationship between Taurus and Perseus?



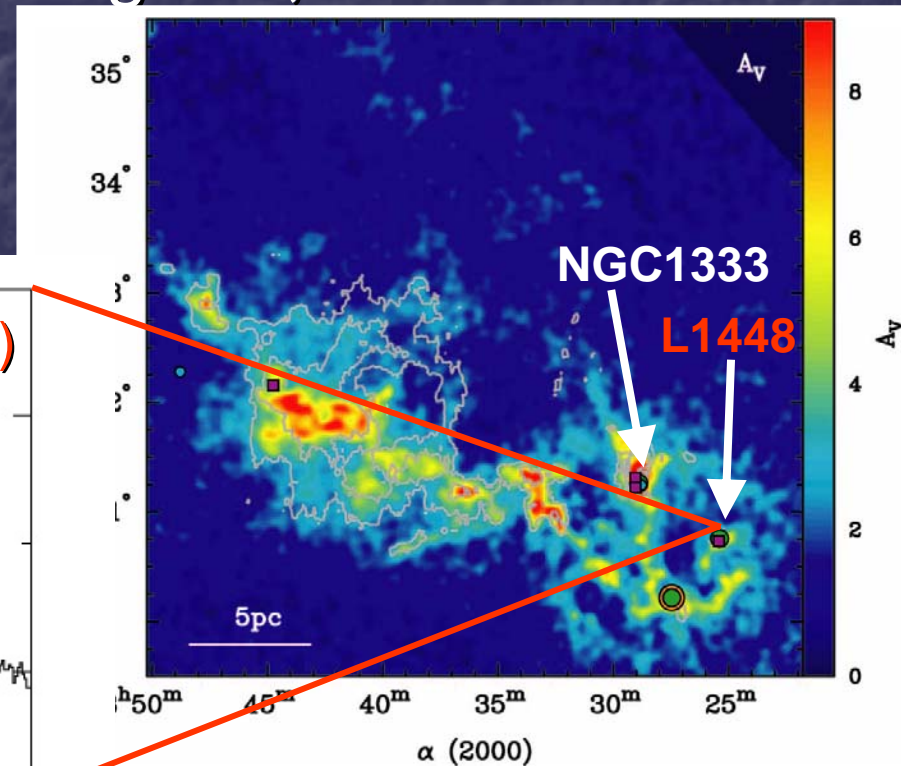
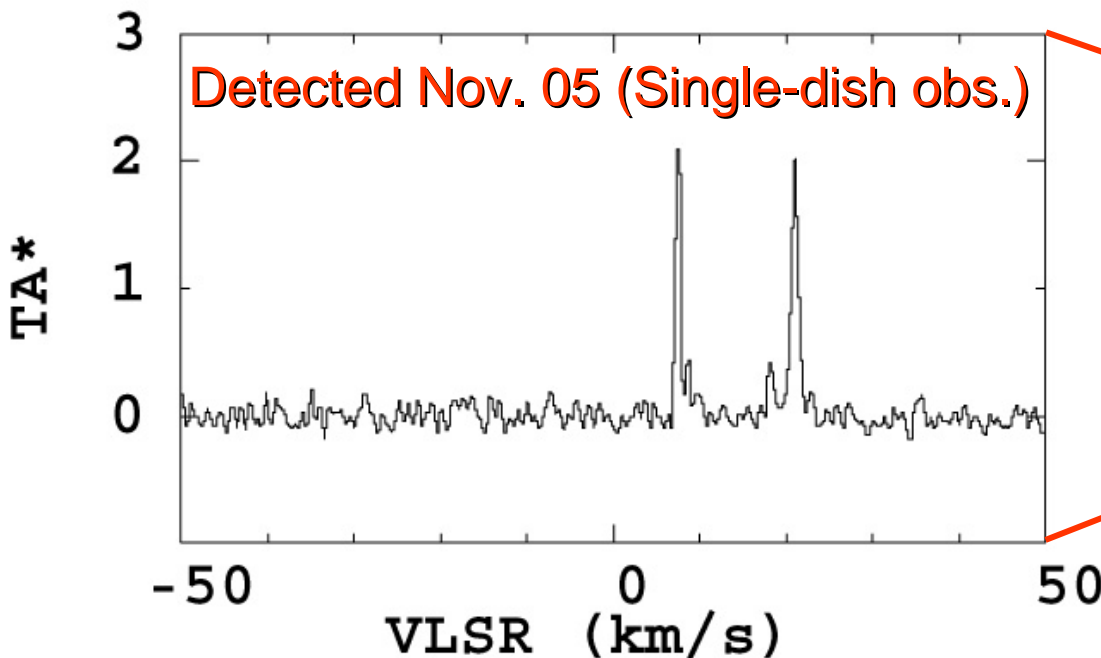
Distance to dark clouds (Cernis 1993)



Distribution of molecular clouds
= A_v map (Ridge et al. 2006)¹⁶

Perseus complex

- Nearest cluster forming region
- Chain of dark clouds and HII regions, and OB clusters
 - 3D structure of clouds?
 - Relationship between Taurus and Perseus?



Distribution of molecular clouds
= A_V map (Ridge et al. 2006)¹⁷

Summary

- Distances to Orion KL, NGC1333 and IRAS 16293-2422 were reported.
- Annual parallax of Orion KL will be refined based on the observations of the SiO masers
- New observations and further data analyses will be made in order to reveal 3-D structure of molecular clouds and the local arm.
- Observed sources:
 - L1204A, L1448C, others (TBD)
 - TMR-1 (if possible), Serpens SMM-1 (if possible)