Magnetic field of the ring-like molecular cloud: G111

D. Alina
Nazarbayev University, Kazakhstan

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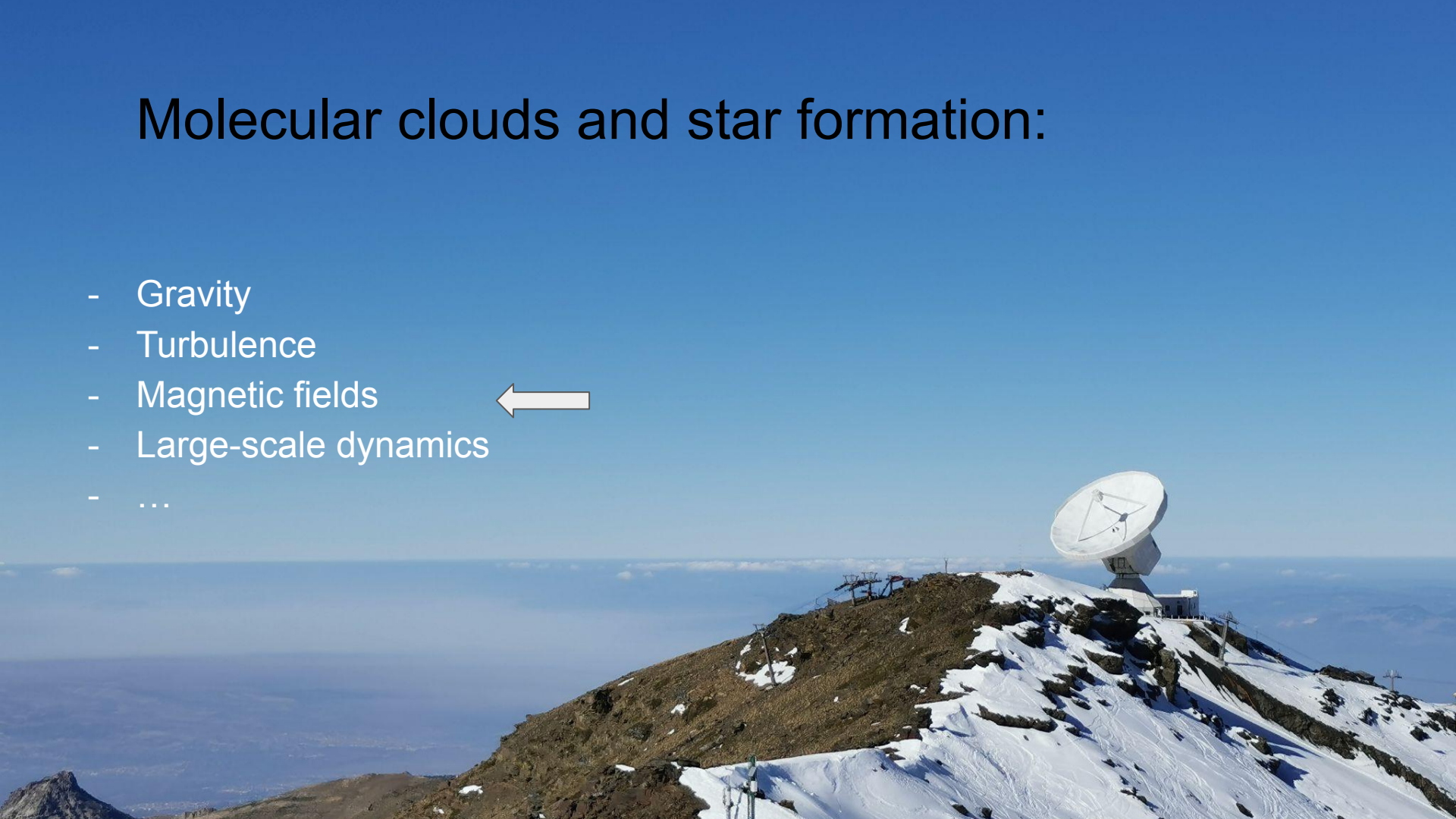
A. Mukash, D. Zhumagaiyr, D. Nurzhakyp, Y. Hu, I. Ristorcelli, J. Montillaud, A. Lazarian, M. Juvela, T.Liu

Molecular clouds formation:

- Gravity
- Turbulence
- Magnetic fields
- Large-scale dynamics
- …

Molecular clouds and star formation:

- Gravity
- Turbulence
- Magnetic fields
- Large-scale dynamics
- …



Magnetic fields and filaments

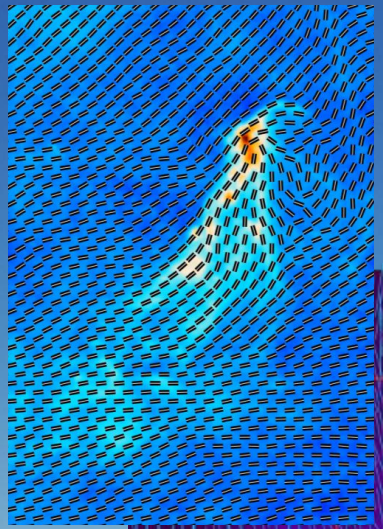
Filaments are a complex and hierarchical phenomenon

On large scales:

- 2 main modes (statistically!): ⊥ for dense and // for low-density
- Dependence on the environment!

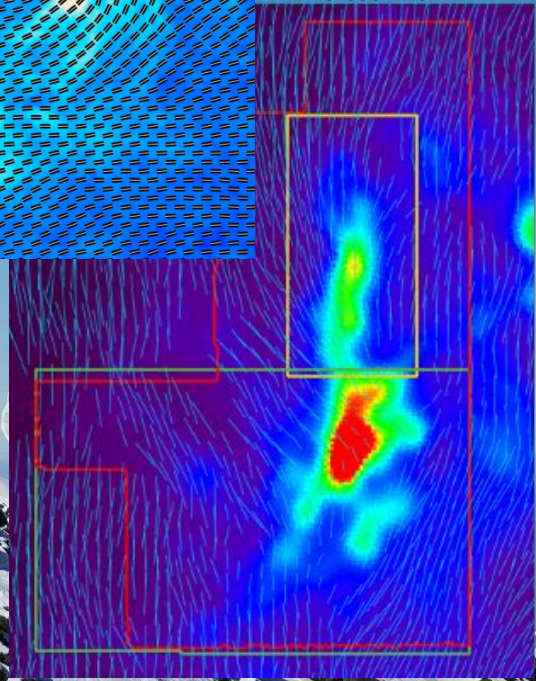
On smaller scales:

- // for dense and for ⊥ low-density

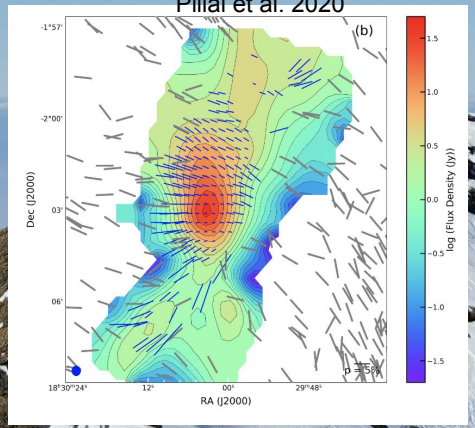


RCrA region
Planck data
Planck XIX 2016

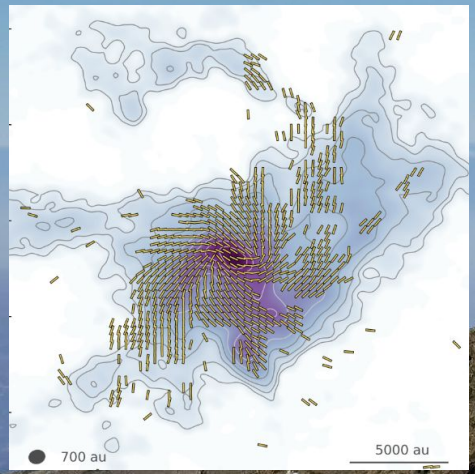
G202 region
Planck data
Alina et al. 2022



A core in the Serpens cloud
HAWC+ data
Pillai et al. 2020



IRAS 18089-1732
ALMA 2.1 cm data
Sanhueza et al. 2021

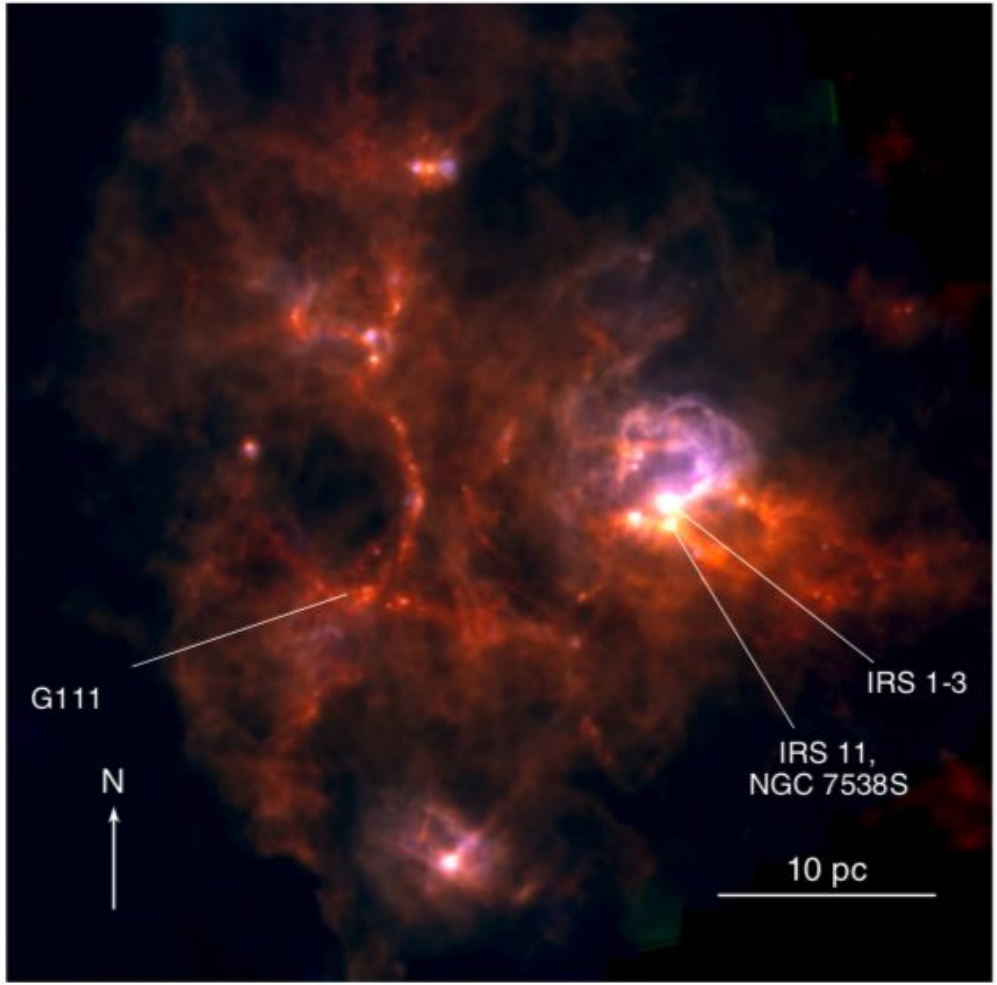


Magnetic fields and filaments

- Magnetic field may affect structure formation
- Formation history of the structures may affect the magnetic field

- Magnetic field affects star formation

Target: G111.75+0.59

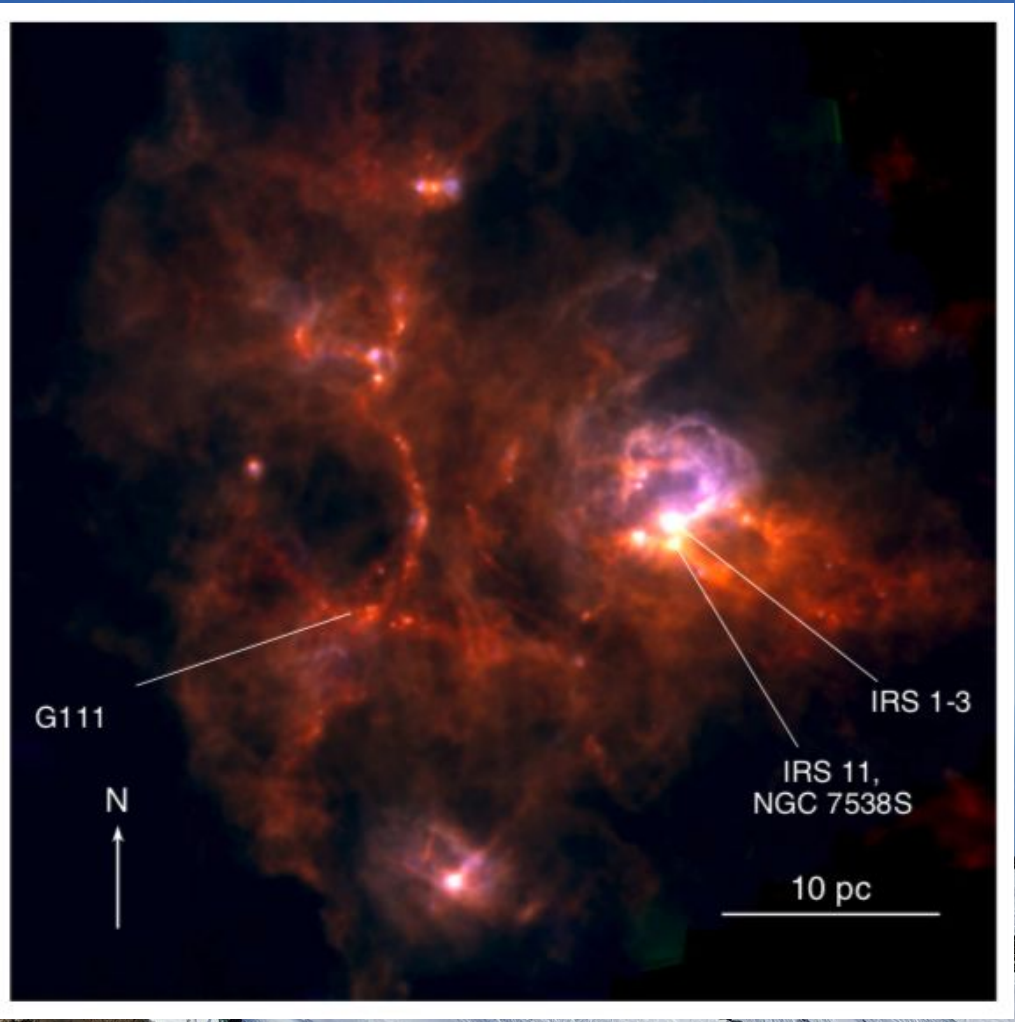


Herschel data: Pacs 70, 160, Spire 250, HOBYS program Falscheer et al. 2013

Target: G111.75+0.59

Distance : ~2.7 kpc (Moscadelli et al. 2009) - ~3.1 kpc (Frieswijk et al. 2007)

No SNR or star inside the ring



Herschel data: Pacs 70, 160, Spire 250, HOBYS program Falscheer et al. 2013

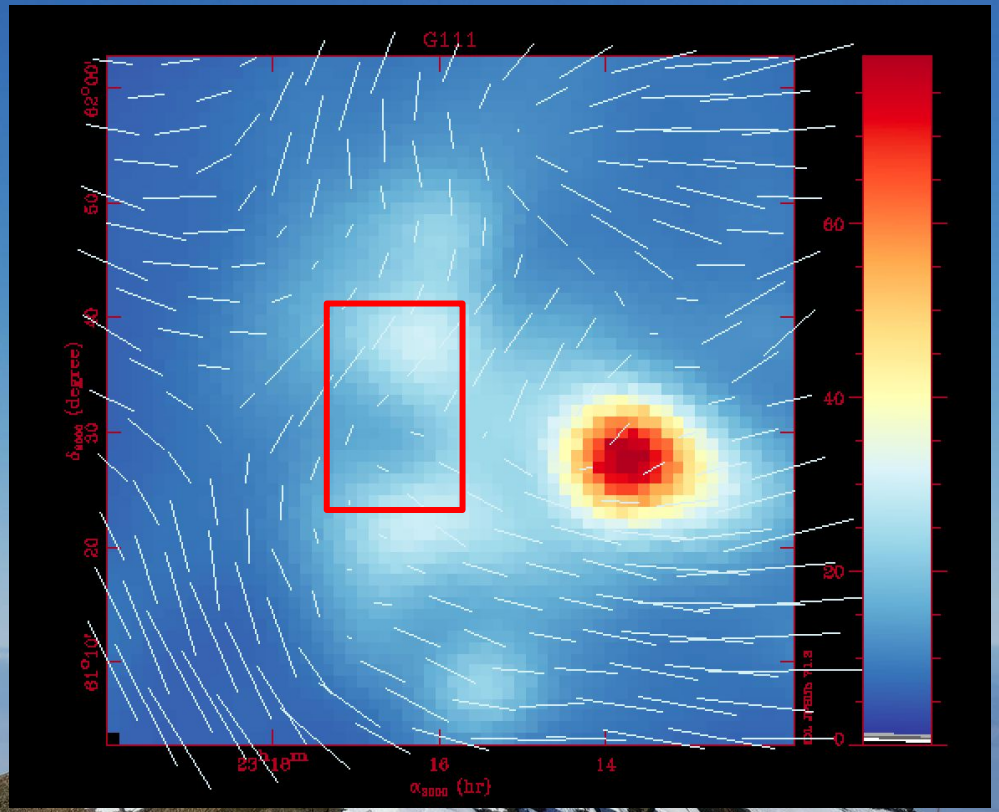
Target: G111.75+0.59

PGCC G111.75+0.59

Herschel HOBYS target

JCMT 850 microns

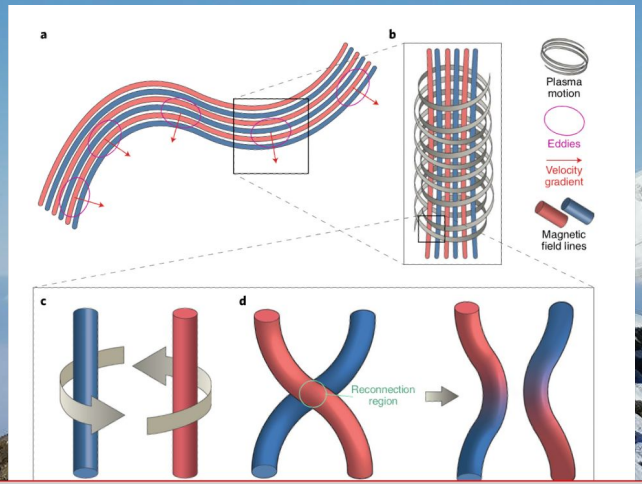
TOPSCOPE target: TRAO 13CO, C18O data

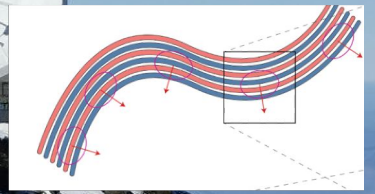


Velocity gradients technique

- Based on a MHD turbulence theory (Goldreich & Sridhar 1995, followed by Lazarian & Vishniac, Lazarian & Pogosyan, Yuen & Lazarian, see Lazarian et al. 2018)

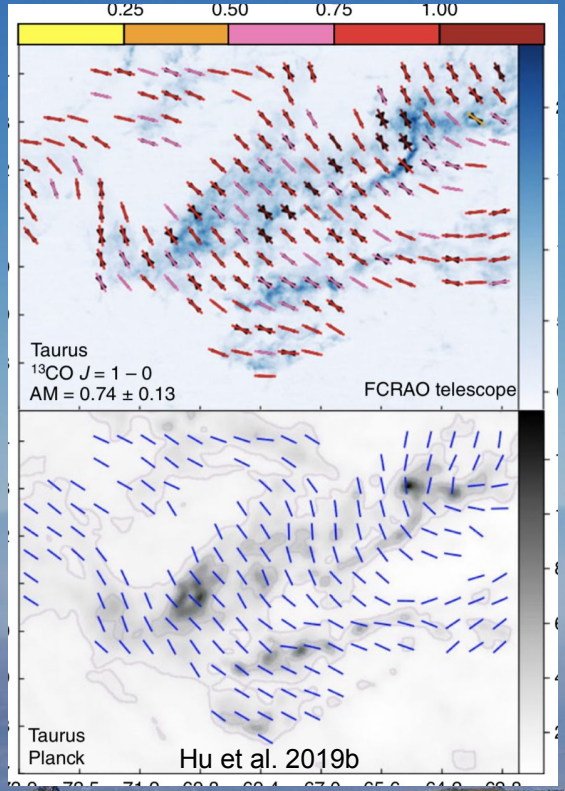
- ❖ Anisotropic turbulence
- ❖ Stochastic flux freezing
- ❖ Magnetic reconnection



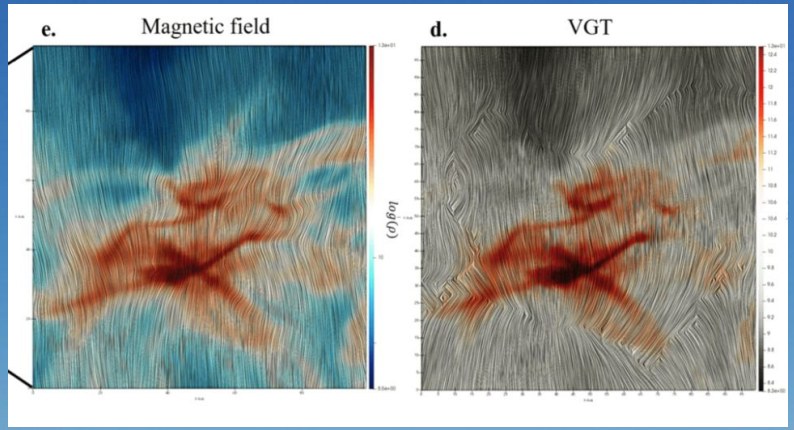


In absence of self gravity and shocks the gradient of velocity is ⊥ to the local B field

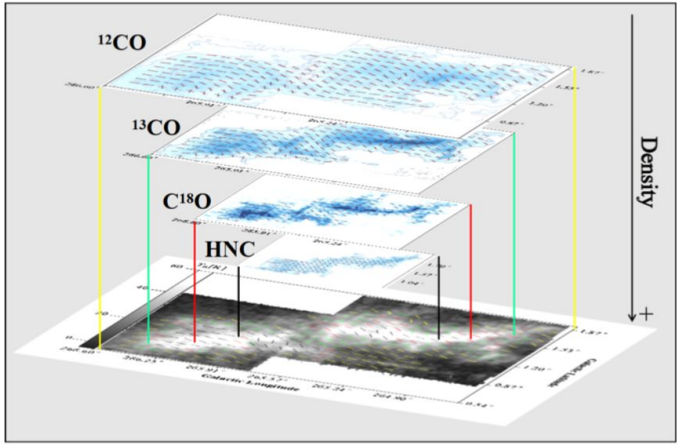
Velocity gradients technique



Hu et al. 2019b

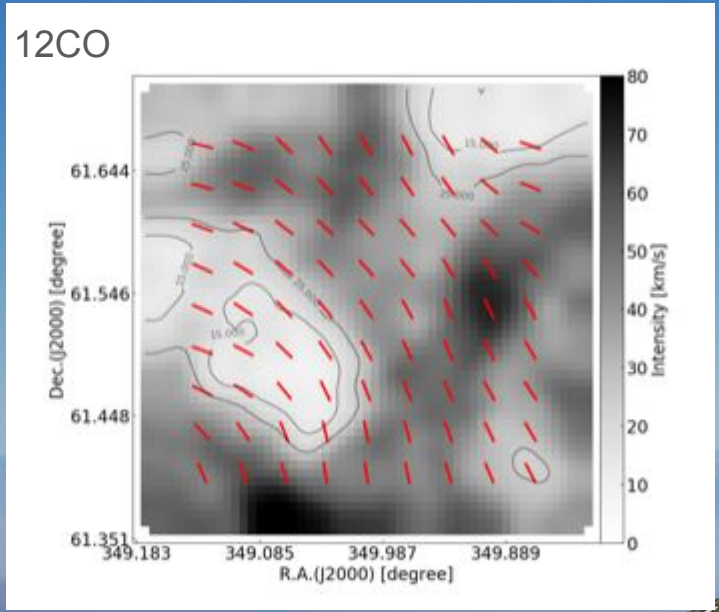


Hu et al. 2019a, 2020

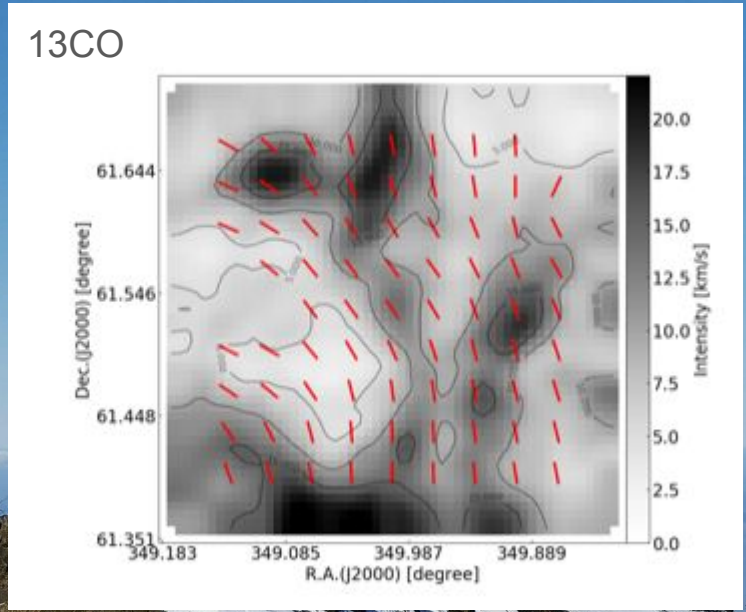


G111.75+0.59: TRAO 14m data, VGTs

12CO

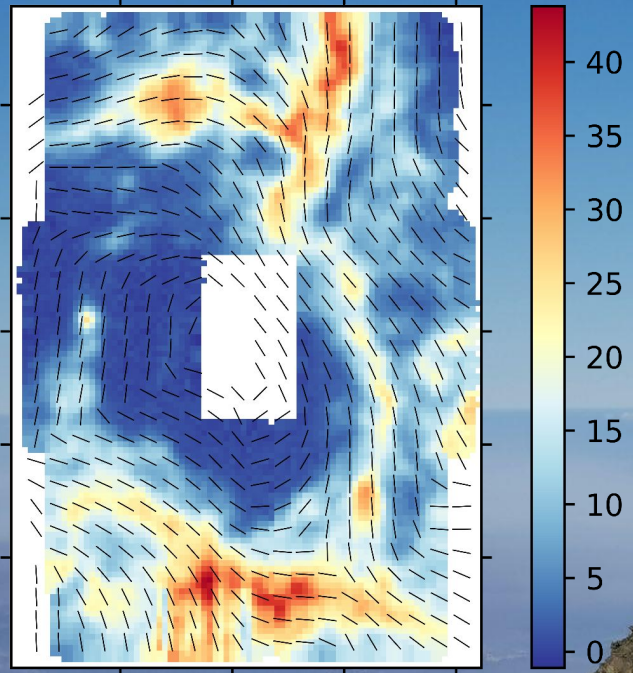


13CO

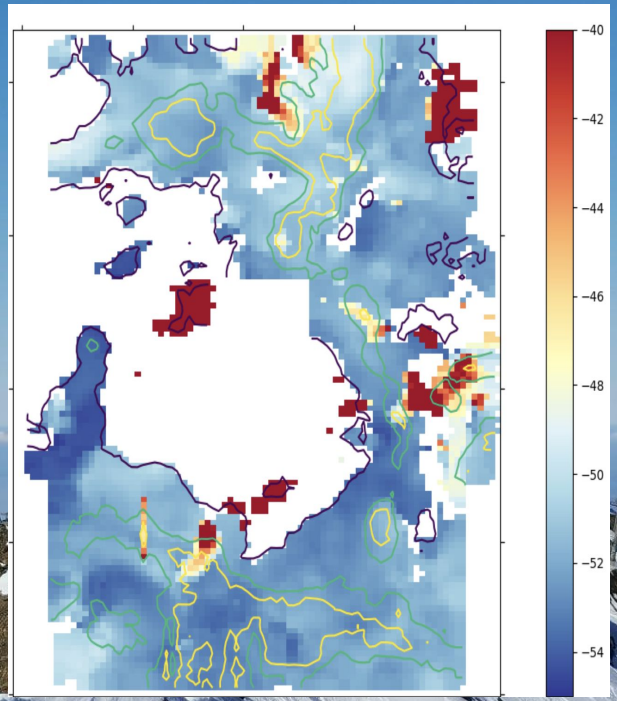


G111.75+0.59: IRAM 30 data, VGTs, 13CO

13CO, -59 to -42 km/s

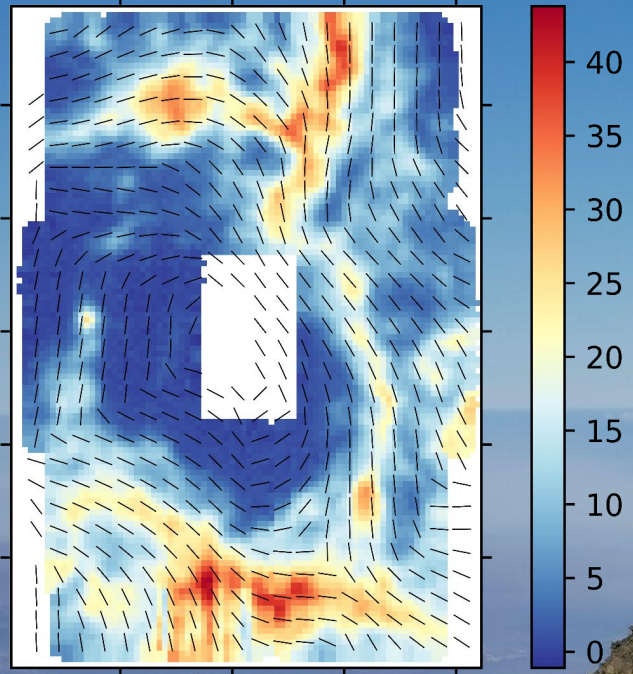


13CO, velocity map

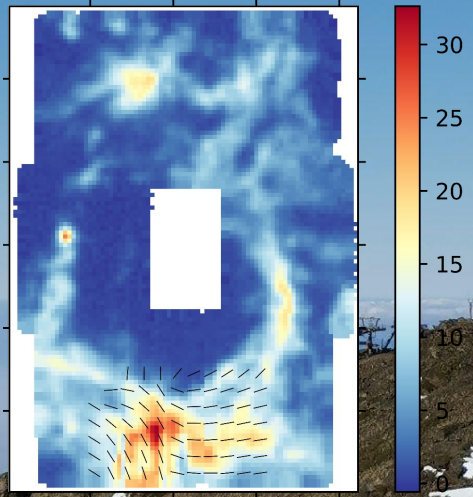


G111.75+0.59: IRAM 30 data, VGTs, 13CO

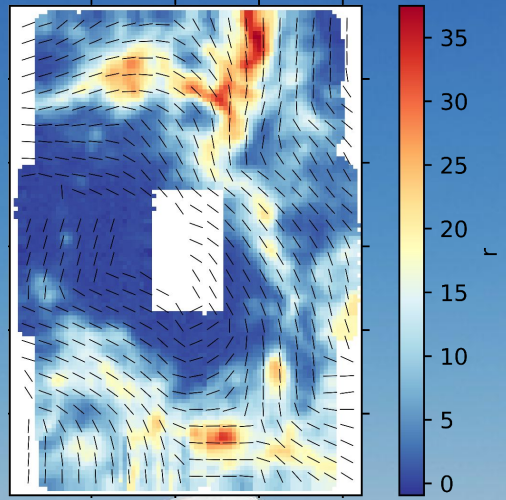
13CO, -59 to -42 km/s



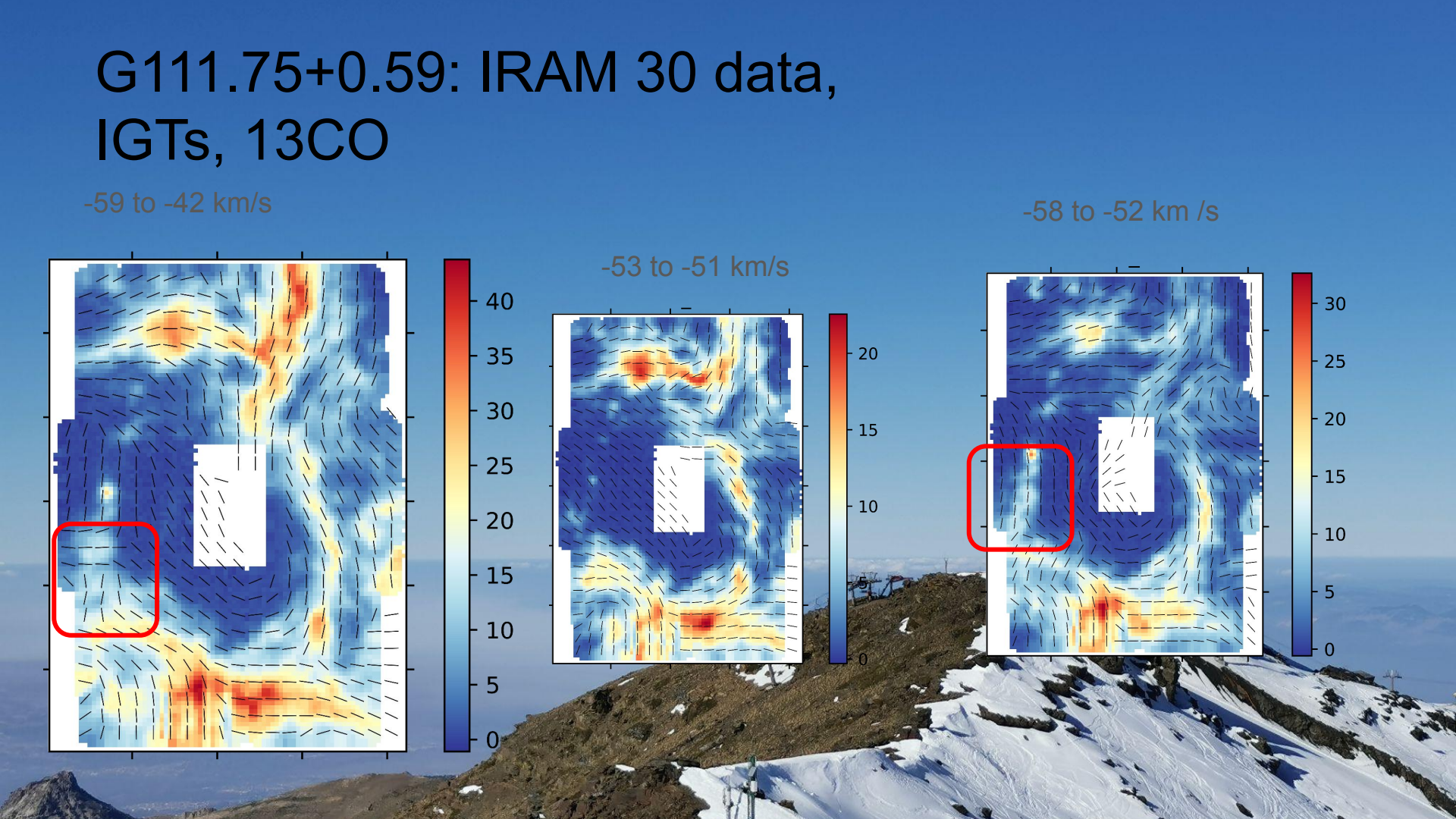
-58 to -52 km/s



-53 to -46 km /s

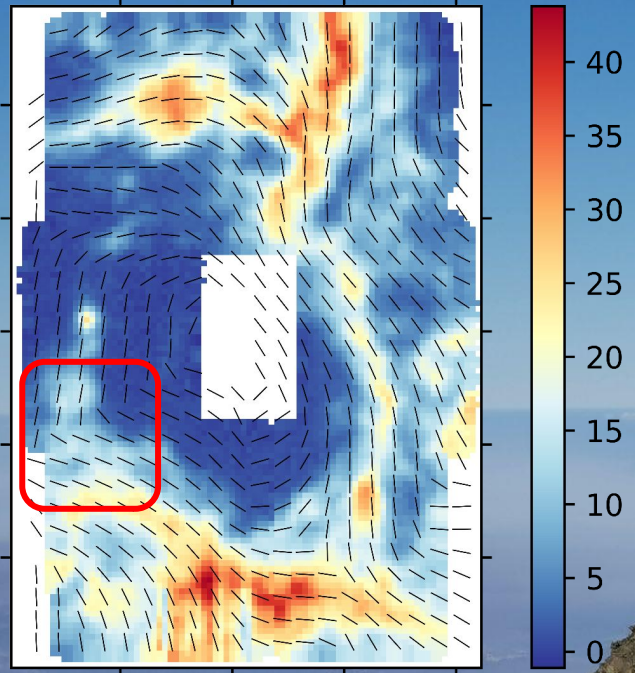


G111.75+0.59: IRAM 30 data, IGTs, 13CO

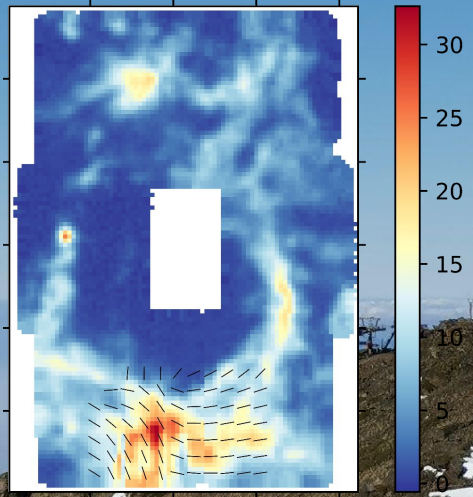


G111.75+0.59: IRAM 30 data, VGTs, 13CO

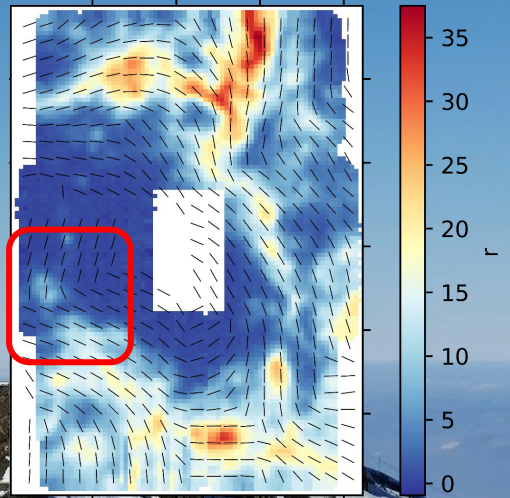
13CO, -59 to -42 km/s



-58 to -52 km/s



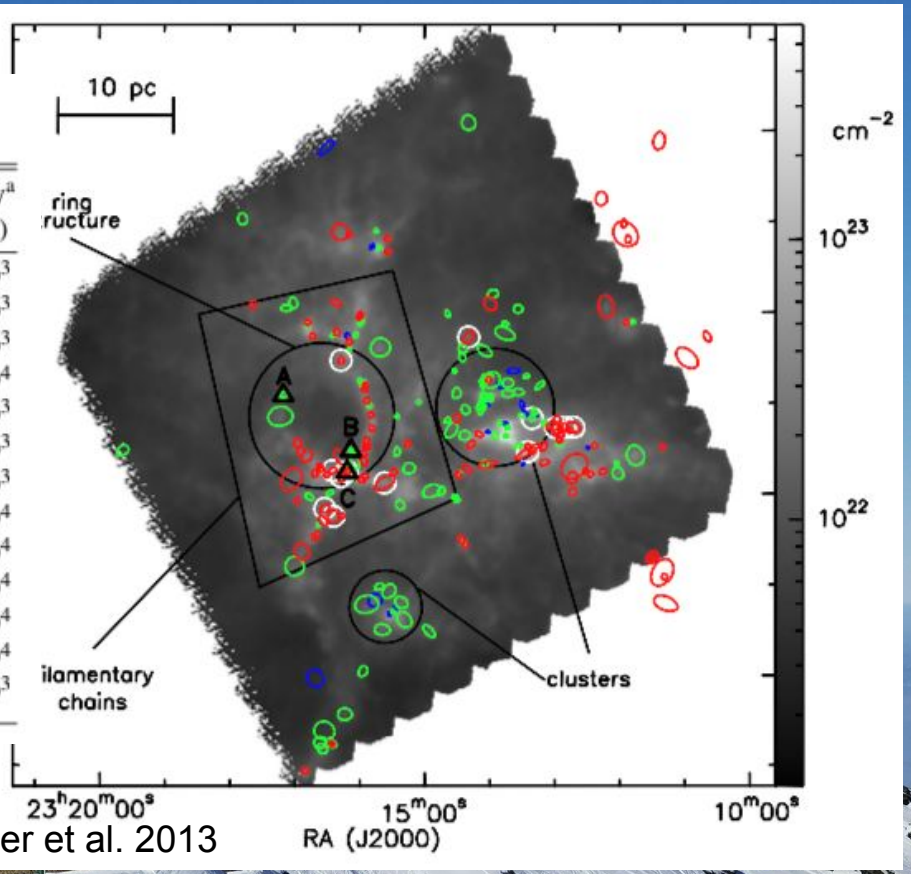
-53 to -46 km /s



Massive clumps in the region

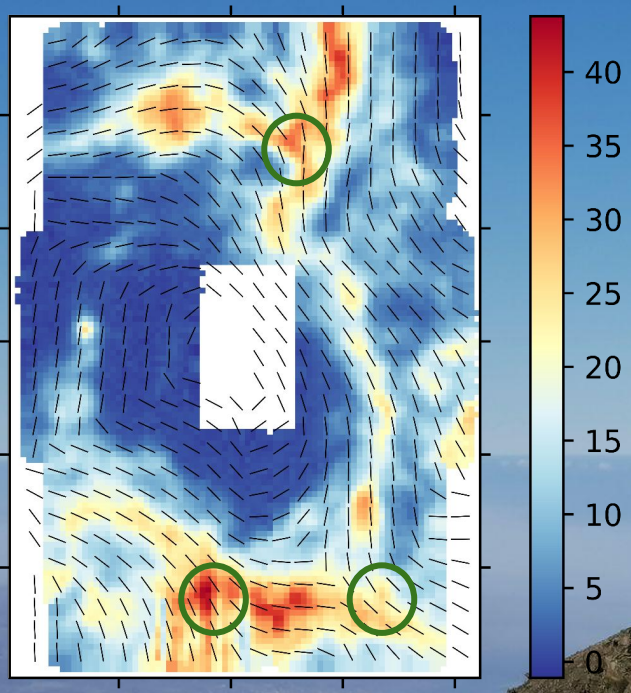
Table 1
Properties of the 13 High-mass Dense Clump (HMDC) Candidate Objects

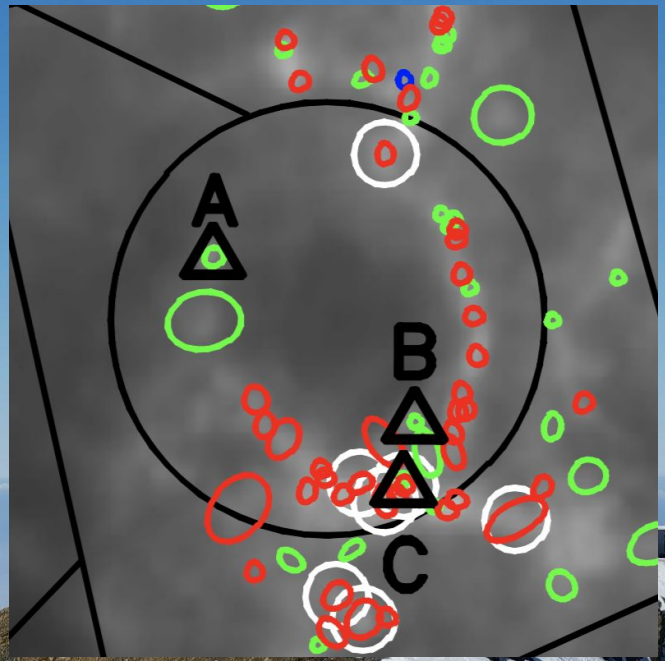
HMDC	R.A. (h:m:s)	Decl. (d:m:s)	Mass ($M_\odot$)	L/M[a] ($L_\odot/M_\odot$)	Size[a] (pc)	Temp[a] (K)	Density[a] (cm^{-3})
1	23:12:42.5	61:27:47.9	200	0.43	0.9	13	8×10^3
2	23:12:51	61:27:46.7	80	0.66	0.7	14	8×10^3
3	23:12:58.9	61:27:44.1	150	1.2	0.8	15	9×10^3
4	23:13:20.7	61:28:47.7	40	0.85	0.4	14	2×10^4
5	23:13:25	61:25:6.6	340	0.99	1.0	15	7×10^3
6	23:14:19.5	61:37:45.4	82	0.26	0.8	12	5×10^3
7	23:15:36.4	61:21:38.9	140	0.21	1.1	11	4×10^3
8[b]	23:16:10.8	61:22:52.4	76	0.24	0.4	12	4×10^4
9	23:16:16.8	61:22:16.9	160	0.10	0.5	10	4×10^4
10	23:16:17.6	61:35:7.1	70	0.11	0.5	10	2×10^4
11	23:16:23	61:17:55.1	75	0.21	0.6	11	1×10^4
12	23:16:24.3	61:22:56.2	42	0.31	0.5	12	1×10^4
13	23:16:31.3	61:18:46.9	81	0.10	1.1	10	6×10^3



Fallscheer et al. 2013

Massive clumps in the region

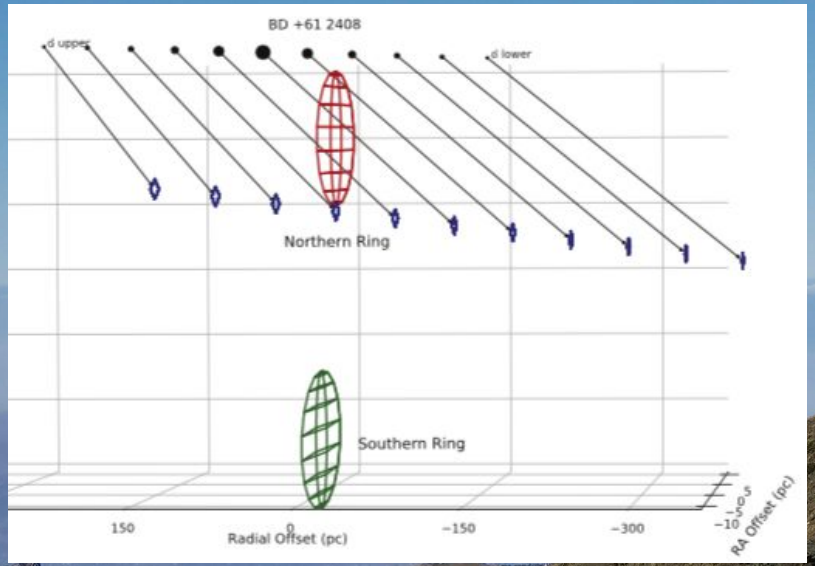


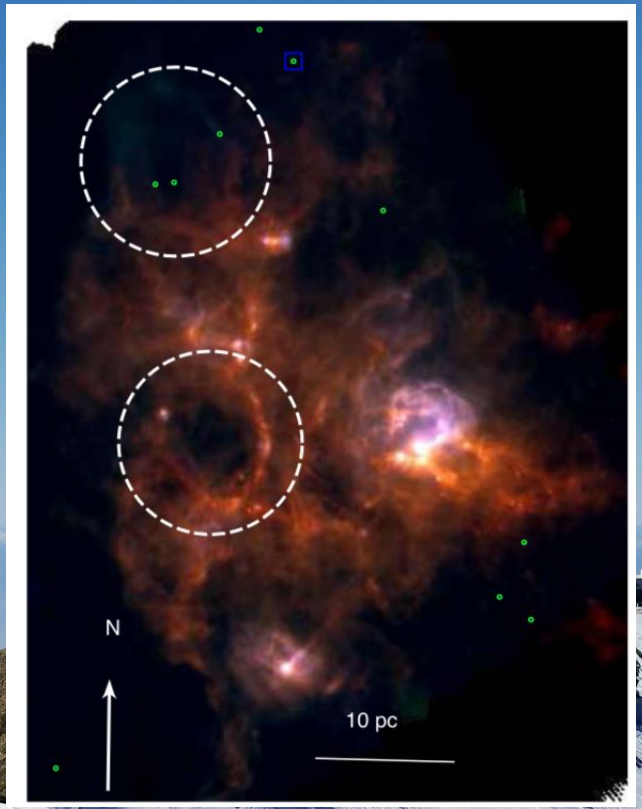


Fallscheef et al. 2013

Possible creation scenario

Fenske et al. 2021: runaway star + bipolar outflow for the upper ring





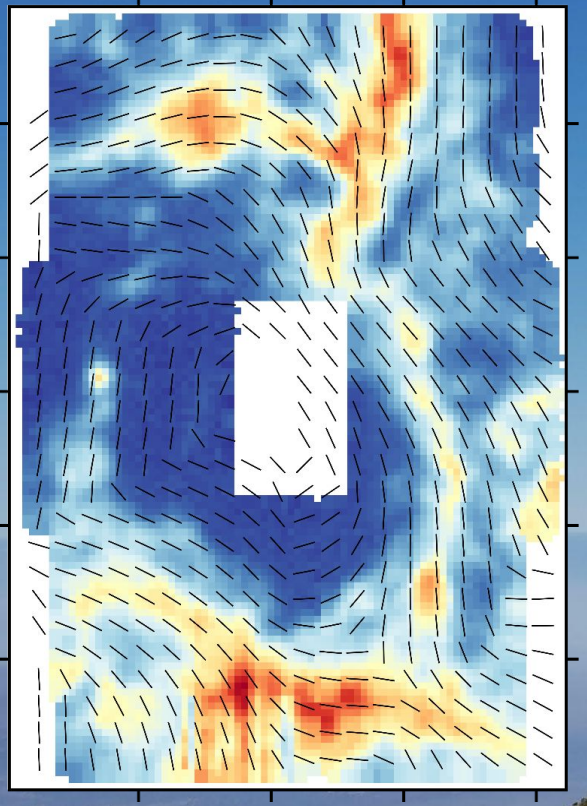
No clear answer yet for the southern ring

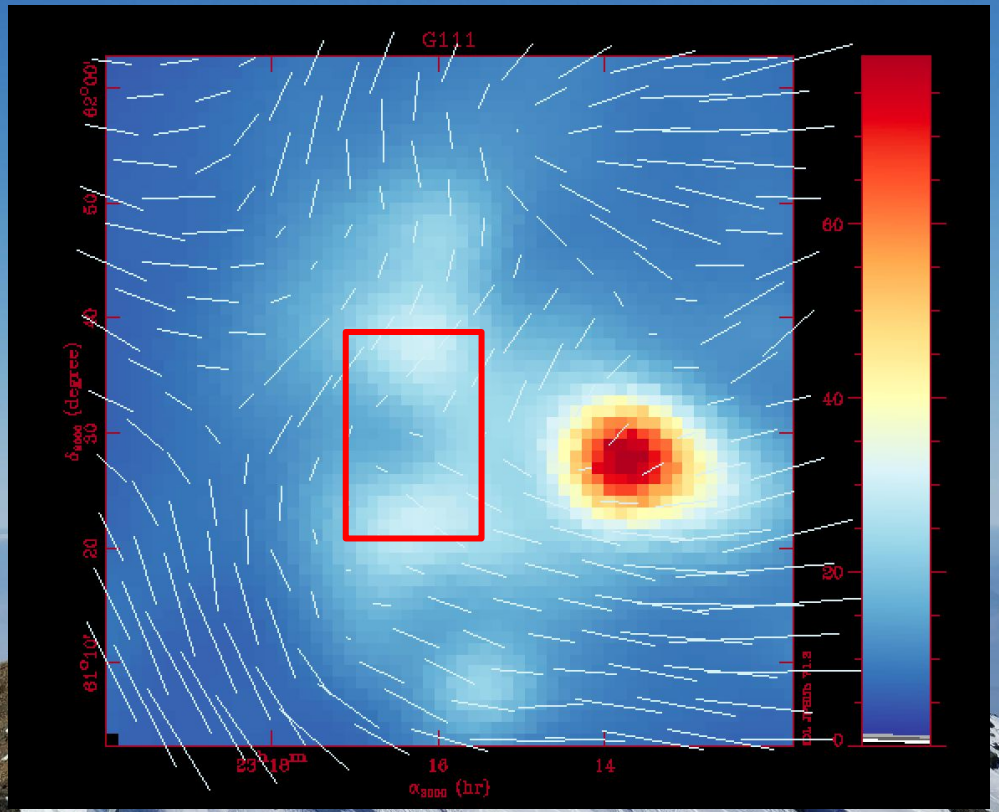
Can the magnetic field geometry help to answer the questions?

Possible creation scenario?

Star formation history?

Comparison of VGT, IGT and polarization?





Next steps

Other tracers?

Polarization with JCMT?

+6h accepted at IRAM 30m (SiO?)