Introducing the Maser Monitoring Organisation (M2O)

Ross A. Burns
EACOA, NAOJ, KASI

High-mass star formation

"High-mass stars"(> 8 $M_\odot$).

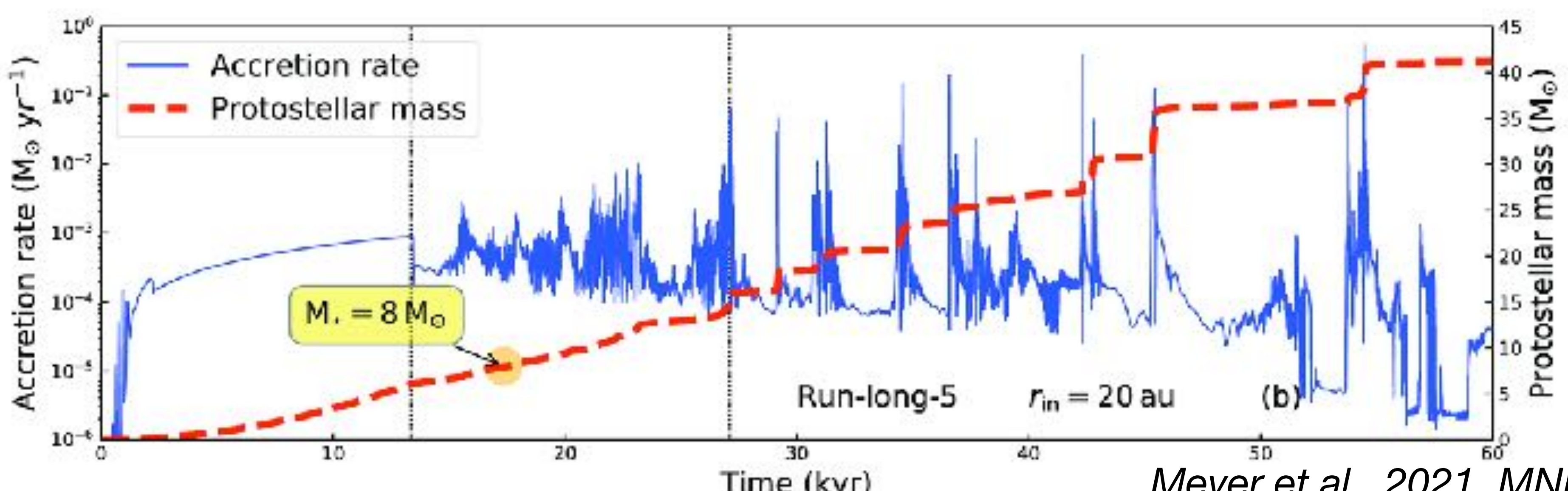
- **Drivers of Galactic evolution; produce heavy elements beyond Iron.**
- **They represent less than 1% of stellar populations and reach MS in < 150 kyr**

Theory

- **Necessarily high continuous accretion rates are not backed up observationally**
- **Disk-aided 'episodic accretion' bursts; between long quiescent phases**
- **Simulations predict that accretion bursts are extremely rare events (typically every 10^3-4 yrs) with a short, transient duration (typically a few years or less)**

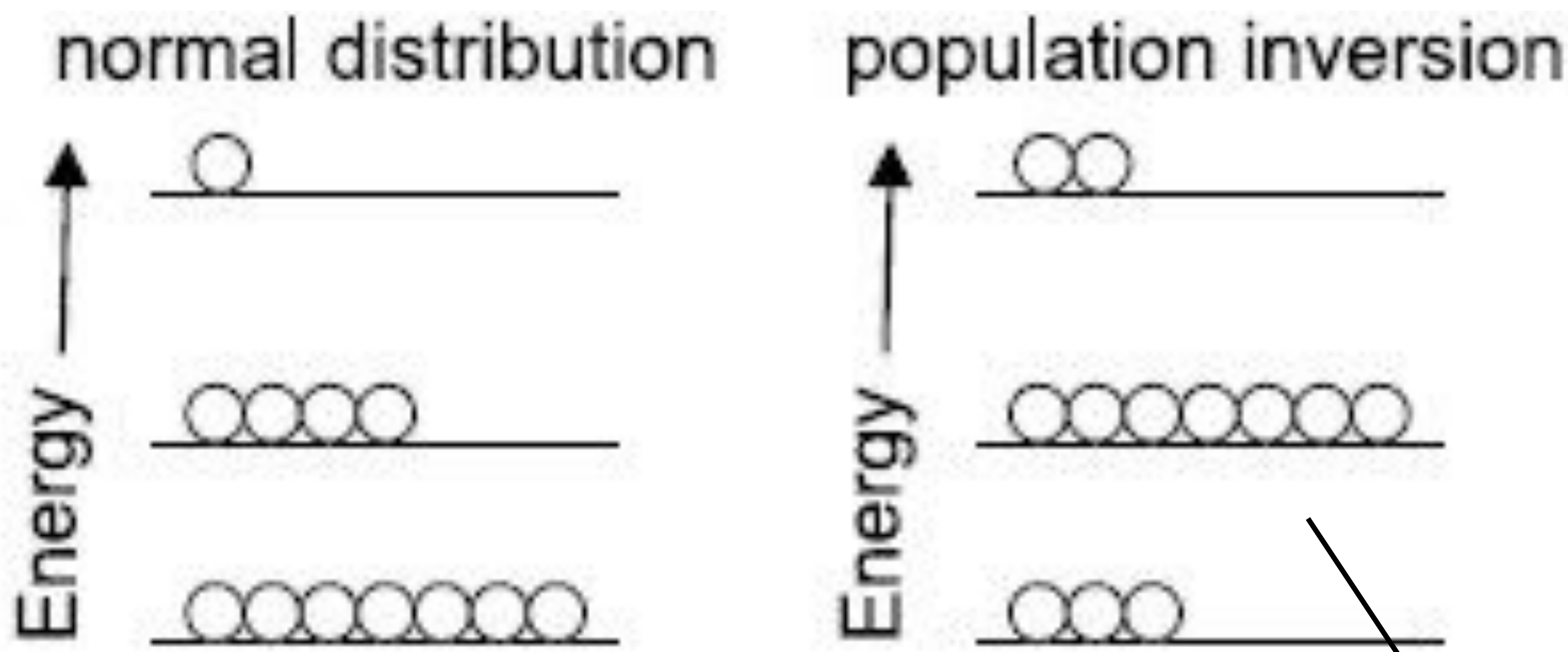
Lacking observational evidence

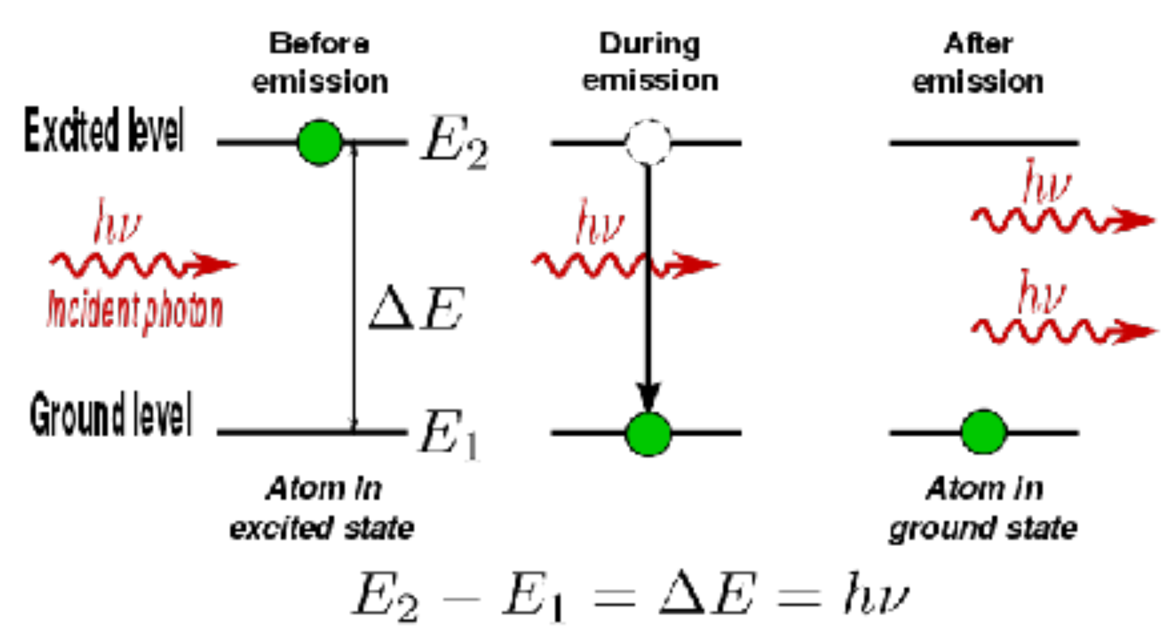
- **High-mass stars typically form in deeply embedded environments at large distances, making them difficult to observe at high spatial resolution.**
- **3 published observationally confirmed accretion bursts in high-mass protostars**



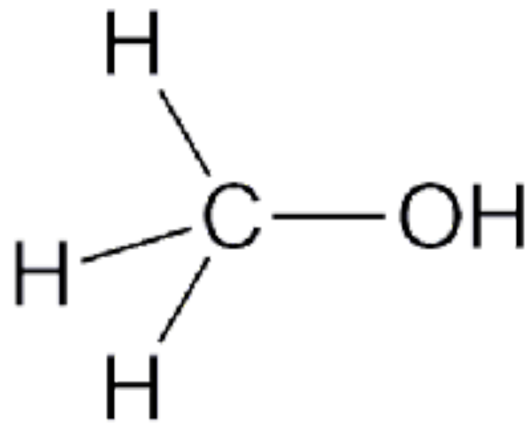
Meyer et al., 2021, MNRAS, 500, 4448

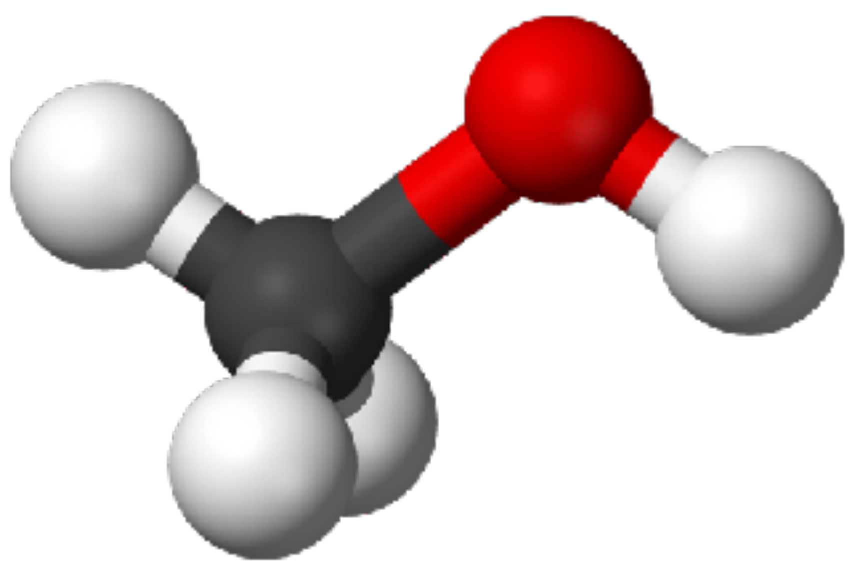
Observational tool: Masers





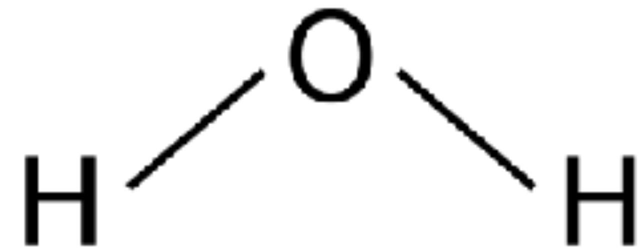
Methanol

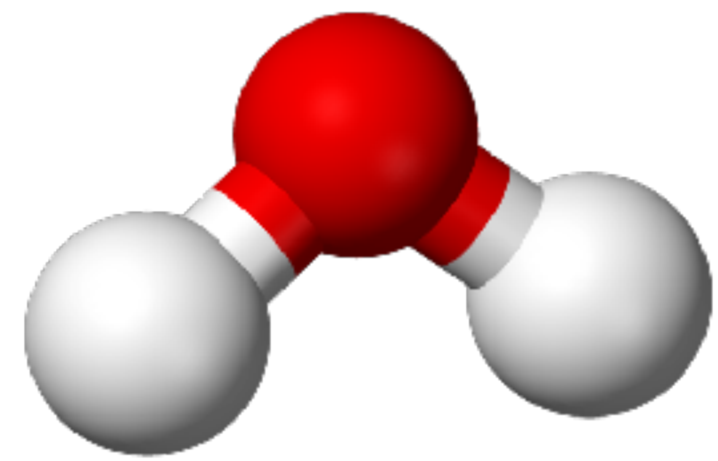




Population inversion (maser) at ~ 150 K

Water

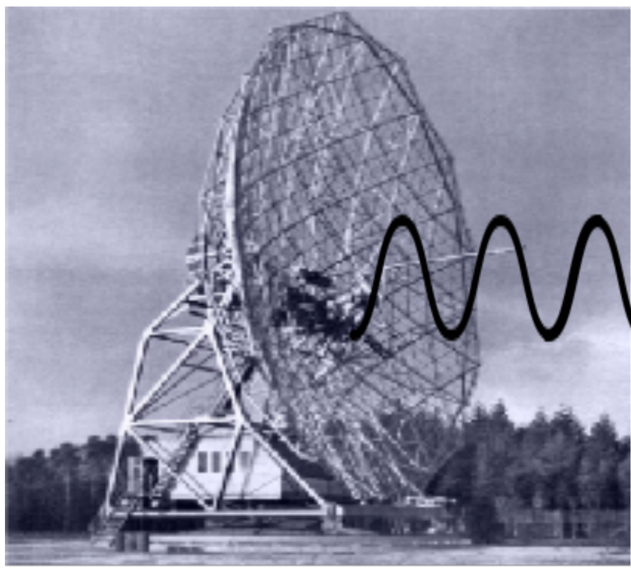


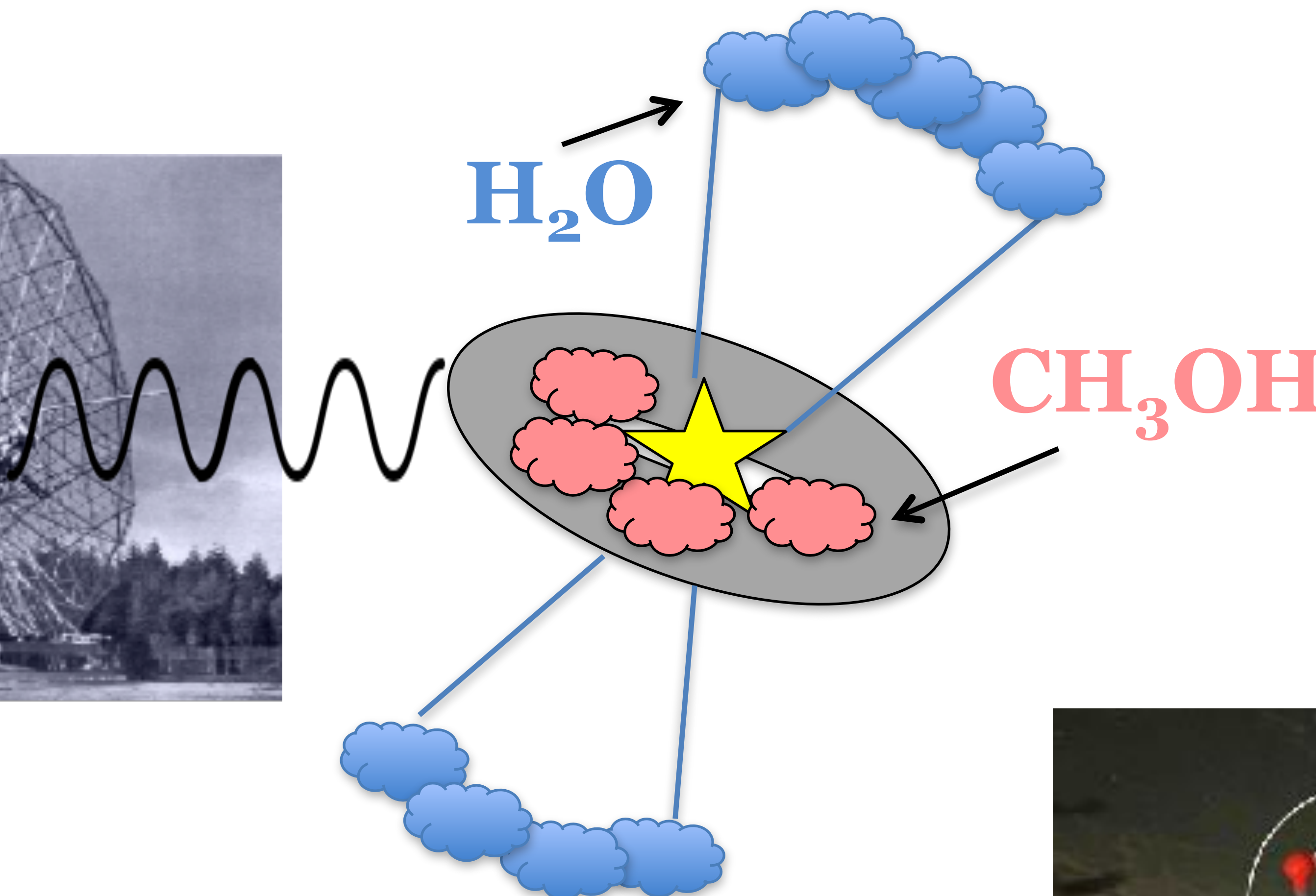


Population inversion (maser) in shocks

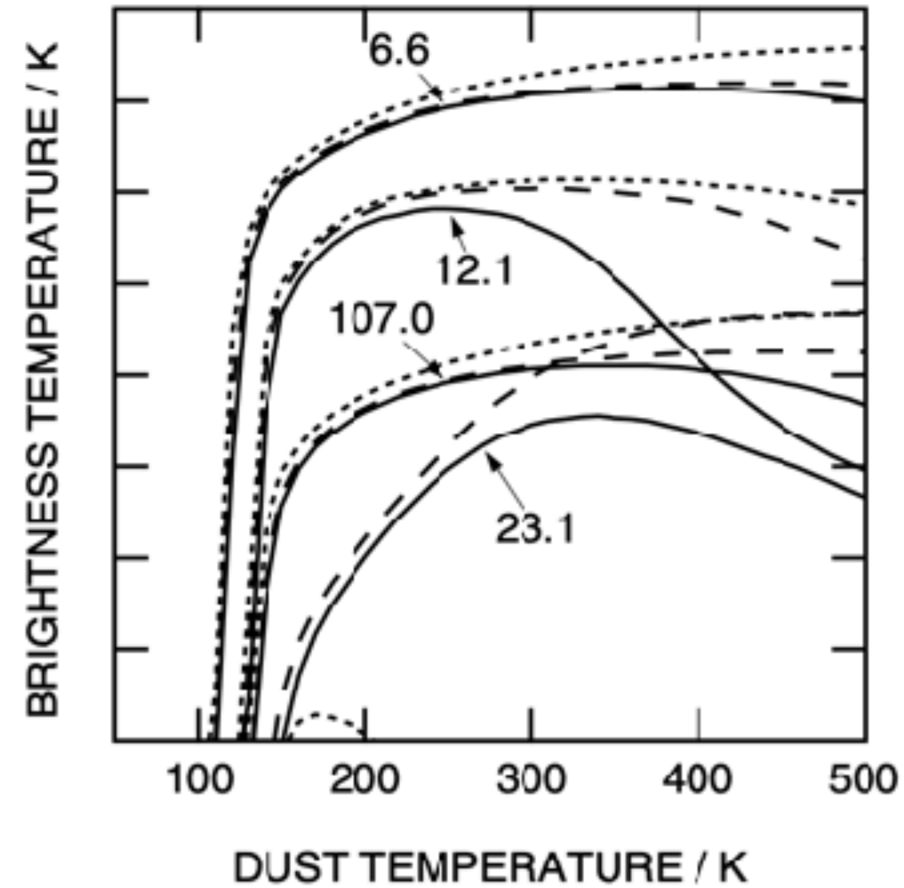
There exist many more molecular maser species, but these are most commonly used

Why masers?





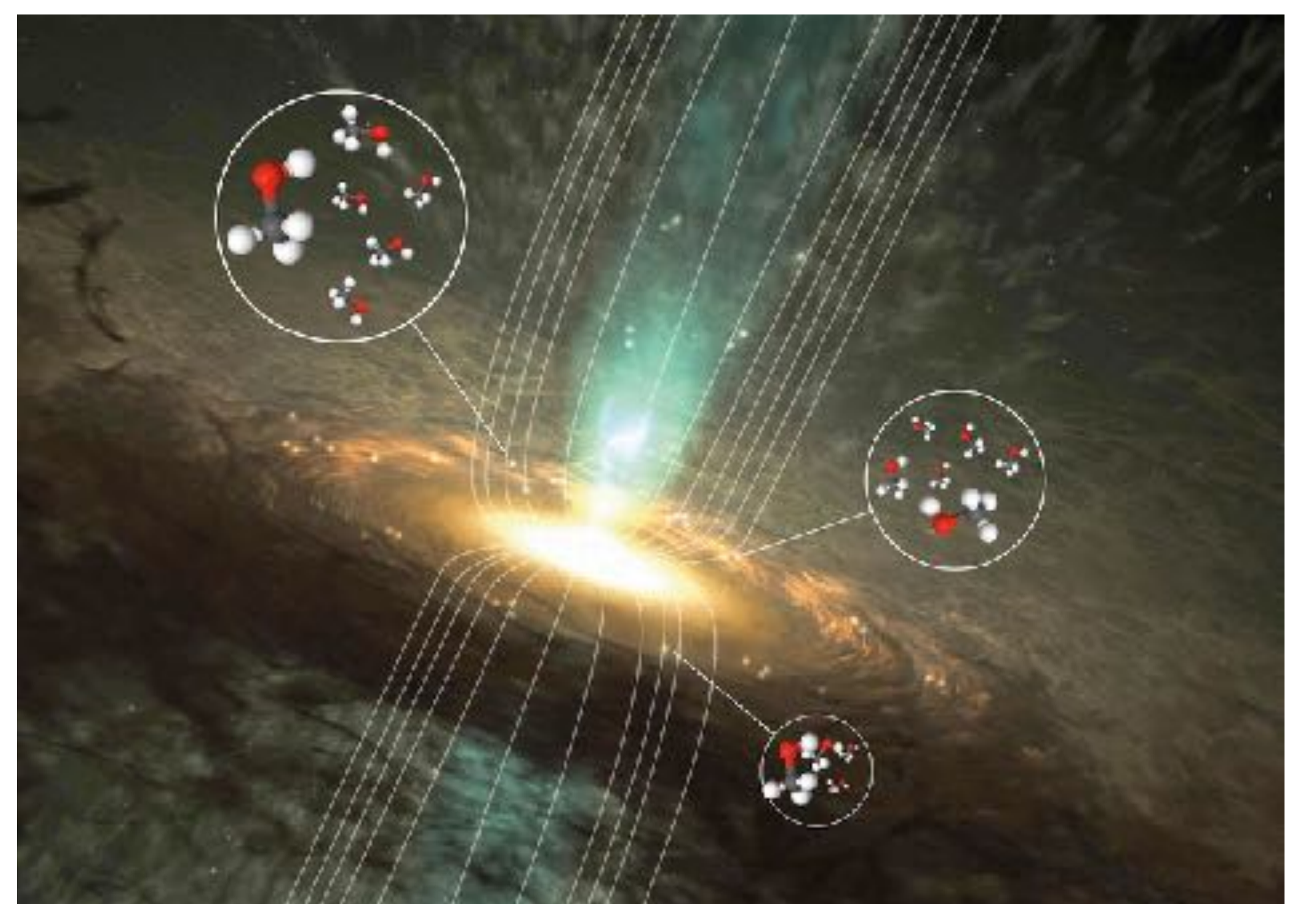
Cragg et al., 2005, MNRAS, 360, 533



Methanol in the disks of high-mass protostars emit maser emission at 6.7 GHz.

The brightness of this emission is highly sensitive to temperature and density.

Changes in maser flux reveal changes in the disk radiation field.



Credit: Wolfgang Steffen /Chalmers/Boy Lankhaar

The Maser Monitoring Organisation (M2O)

Prior:

- **Maser monitoring programmes already existed, but were not talking to each other.**
- **Transient events were only reported long after their occurrence.**

Launch: 2017/09/07 **@IAU Symp. 336 on Masers**

Participants: Australia, Canada, China, France, Italy, Japan, Korea, Latvia, Poland, Russia, South Africa, Thailand, Ukraine, USA

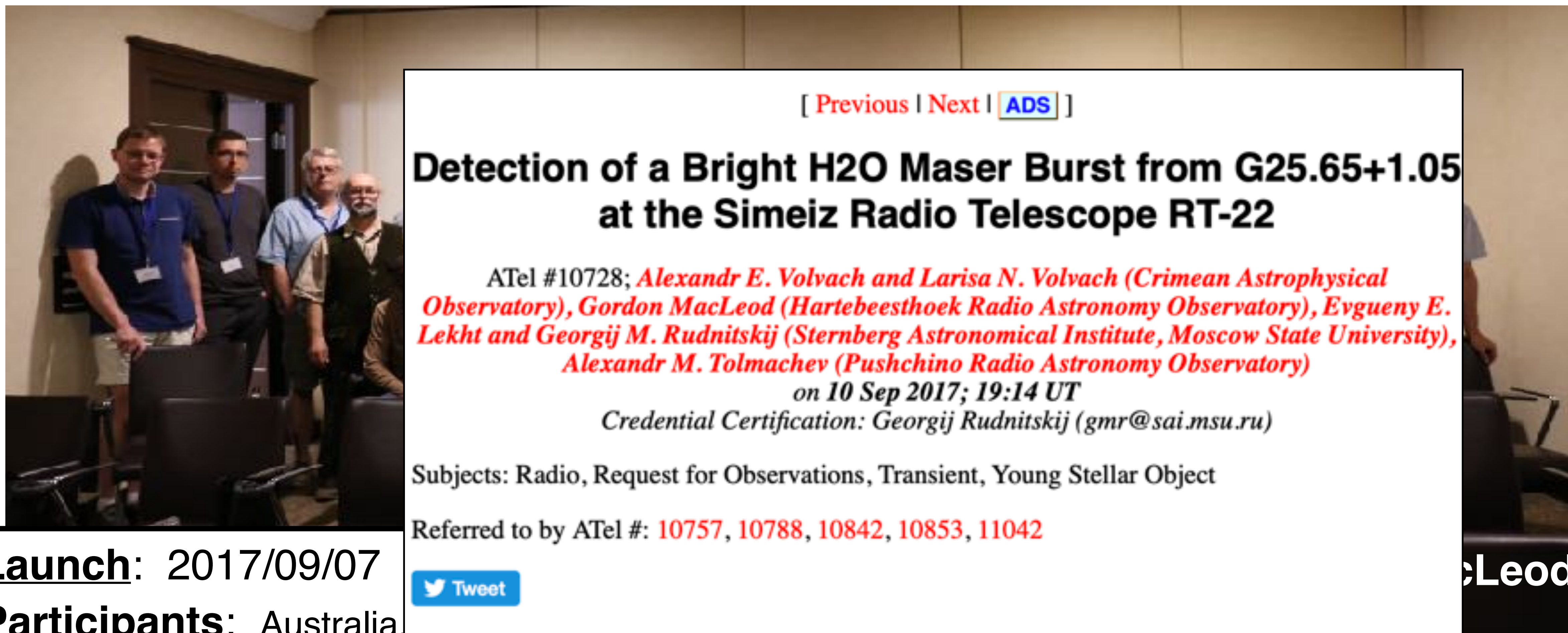
Initial goals of the M2O:

- **Initiate communications between monitoring programs to avoid duplicating efforts**
- **To alert the community to transient events**

The Maser Monitoring Organisation (M2O)

Prior:

- **Maser monitoring programmes already existed, but were not talking to each other.**
- **Transient events were only reported long after their occurrence.**



[Previous | Next | ADS]

Detection of a Bright H2O Maser Burst from G25.65+1.05 at the Simeiz Radio Telescope RT-22

ATel #10728; *Alexandr E. Volvach and Larisa N. Volvach (Crimean Astrophysical Observatory), Gordon MacLeod (Hartebeesthoek Radio Astronomy Observatory), Evgueny E. Lekht and Georgij M. Rudnitskij (Sternberg Astronomical Institute, Moscow State University), Alexandr M. Tolmachev (Pushchino Radio Astronomy Observatory)*
*on **10 Sep 2017; 19:14 UT***
Credential Certification: Georgij Rudnitskij (gmr@sai.msu.ru)

Subjects: Radio, Request for Observations, Transient, Young Stellar Object

Referred to by ATel #: 10757, 10788, 10842, 10853, 11042

Tweet

The source of maser emission in 22.235-GHz H2O line in the star-forming region G25.65+1.05 has experienced a new rapid flare. The peak flux density of the main feature at VLSR = 42.5 km/s was: 2017 April 26 - 600 Jy (Simeiz RT-22 radio telescope); 2017 May 12 - 400 Jy (Simeiz); 2017 June 13 - 410 Jy (Simeiz); 2017 July 25 - 316 Jy (Pushchino RT-22 radio telescope); 2017 August 10 - 620 Jy (Simeiz); 2017 August 21 - 840 Jy (HartRAO); 2017 August 25 - 813 Jy (Pushchino); 2017 August 27 - from 1400 Jy to 2500 Jy (Simeiz); 2017 September 7 - 17000 Jy (Simeiz); 2017 September 8 - 20500 Jy (Simeiz); 2017 September 9 - 21000 Jy (HartRAO). As observed previously in Pushchino, the H2O maser G25.65+1.05 had a strong flare in November-December 2016, its peak flux density exceeding 40000 Jy (paper submitted to Astronomy Reports). Follow-up observations of this source are highly desirable.

Launch: 2017/09/07
Participants: Australia,
Latvia, Poland, Russia, Sou

Initial goals of the M2O

- **Initiate communicati ng efforts**
- **To alert the communi**

The Maser Monitoring Organisation (M2O)

, but were not talking to each other.
their occurrence.

VLBI observations of the G25.65+1.05 water maser superburst

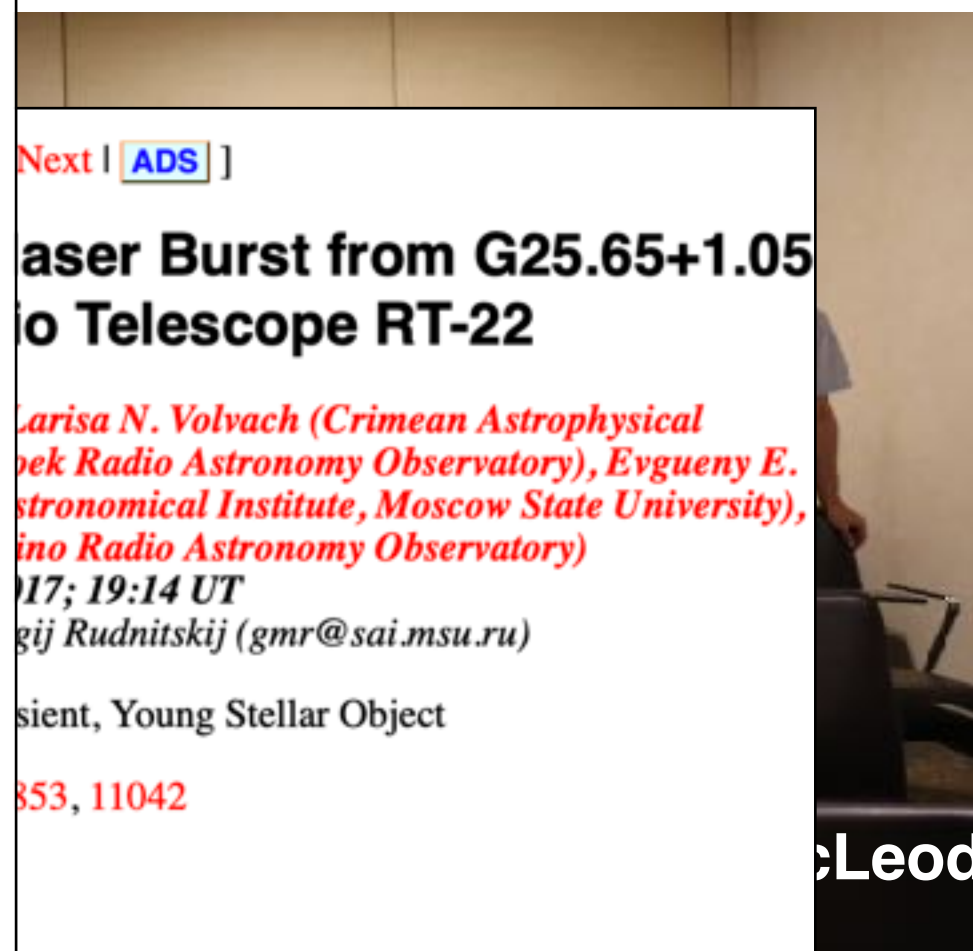
R A Burns, G Orosz, O Bayandina, G Surcis, M Olech, G MacLeod, A Volvach,
G Rudnitskii, T Hirota, K Immer ... Show more

Monthly Notices of the Royal Astronomical Society, Volume 491, Issue 3, January 2020, Pages 4069–4075, https://doi.org/10.1093/mnras/stz3172
Published: 14 November 2019 **Article history** ▾

Cite Permissions Share ▾

ABSTRACT

This paper reports observations of a 22 GHz water maser 'superburst' in the G25.65+1.05 massive star-forming region, conducted in response to an alert from the Maser Monitoring Organisation (M2O). Very long baseline interferometry (VLBI) observations using the European VLBI Network (EVN) recorded a maser flux density of 1.2×10^4 Jy. The superburst was investipgated in the spectral, structural, and temporal domains and its cause was determined to be an increase in maser path length generated by the superposition of multiple maser emitting regions aligning in the line of sight to the observer. This conclusion was based on the location of the bursting maser in the context of the star-forming region, its complex structure, and its rapid onset and decay.



Next | ADS]

aser Burst from G25.65+1.05
io Telescope RT-22

Larisa N. Volvach (Crimean Astrophysical
oek Radio Astronomy Observatory), Evgueny E.
stronomical Institute, Moscow State University),
ino Radio Astronomy Observatory)
)17; 19:14 UT
gij Rudnitskij (gmr@sai.msu.ru)

sient, Young Stellar Object

353, 11042

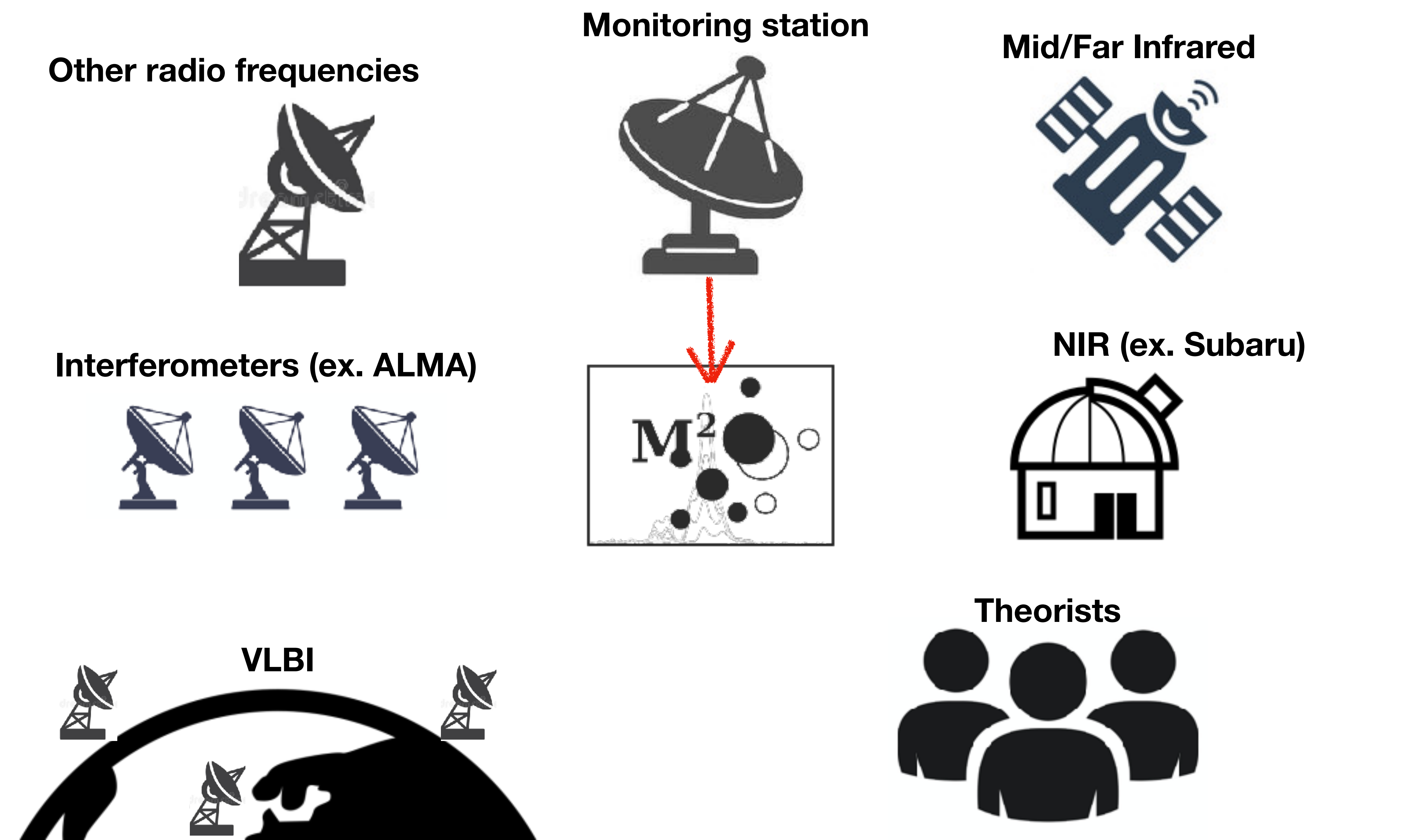
H2O line in the star-forming region G25.65+1.05
density of the main feature at VLSR = 42.5 km/s
dio telescope); 2017 May 12 - 400 Jy (Simeiz);
2017 June 13 - 410 Jy (Simeiz); 2017 July 25 - 316 Jy (Pushchino RT-22 radio telescope); 2017 August 10 - 620 Jy (Simeiz); 2017 August 21 - 840 Jy (HartRAO); 2017 August 25 - 813 Jy (Pushchino); 2017 August 27 - from 1400 Jy to 2500 Jy (Simeiz); 2017 September 7 - 17000 Jy (Simeiz); 2017 September 8 - 20500 Jy (Simeiz); 2017 September 9 - 21000 Jy (HartRAO). As observed previously in Pushchino, the H2O maser G25.65+1.05 had a strong flare in November-December 2016, its peak flux density exceeding 40000 Jy (paper submitted to Astronomy Reports). Follow-up observations of this source are highly desirable.

Initial goals of the M2O

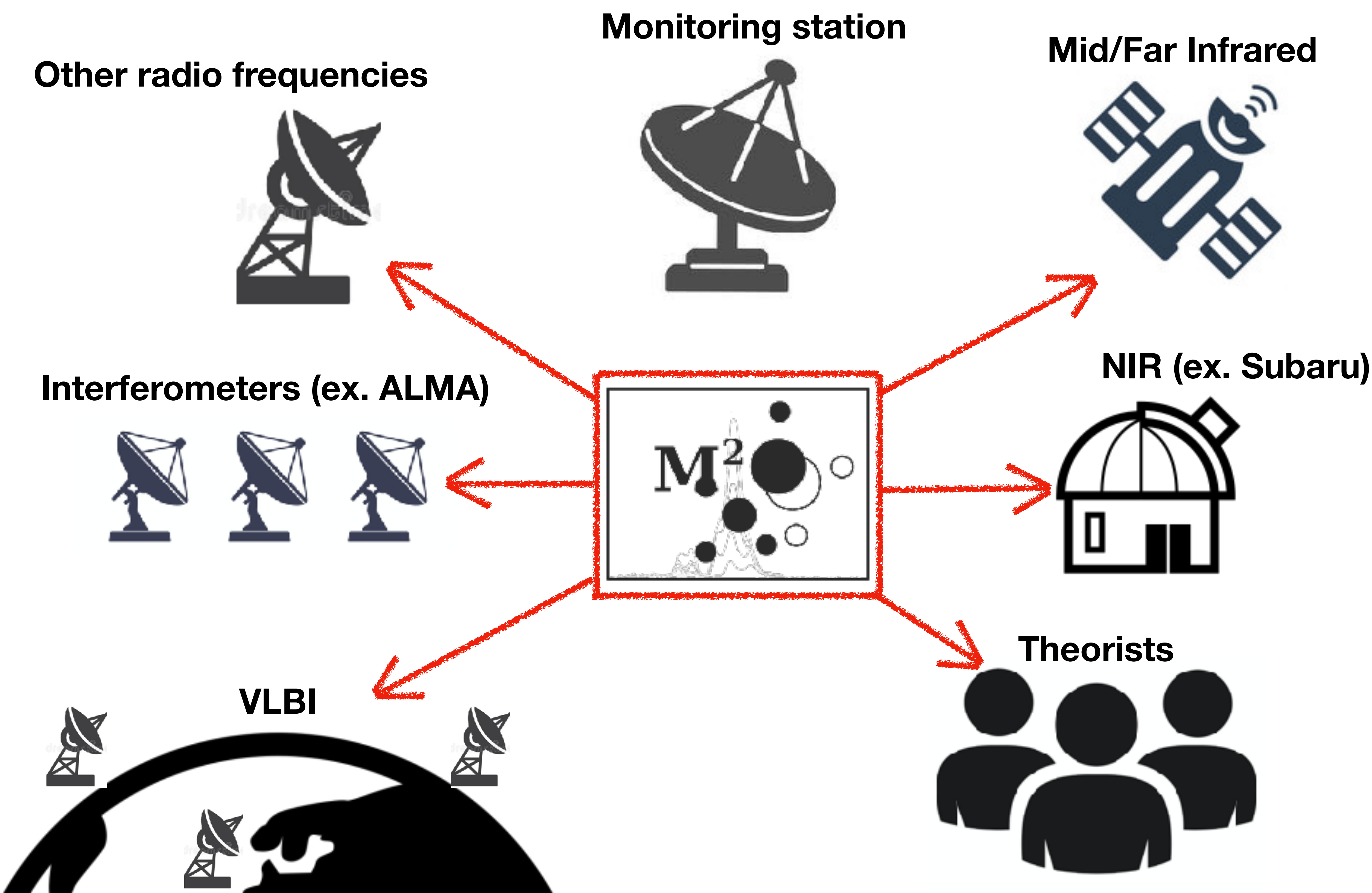
- Initiate communicati ... ng efforts
- To alert the communi


M20
This map was created by a user. Learn how to create your own.
Google My Maps
Map data ©2020 Imagery ©2020 NASA
Terms
5,000 km

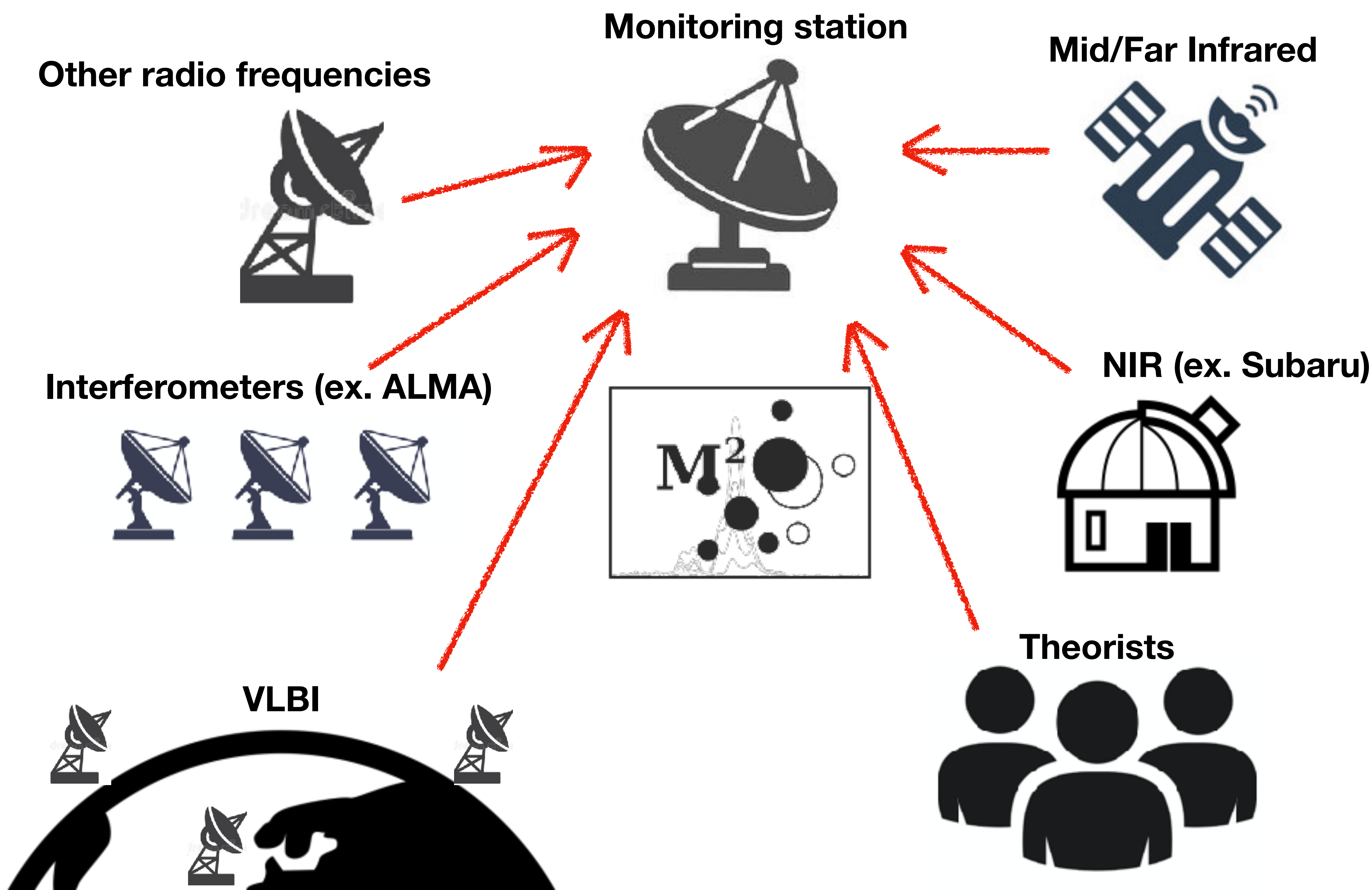
M2O operations



M2O operations

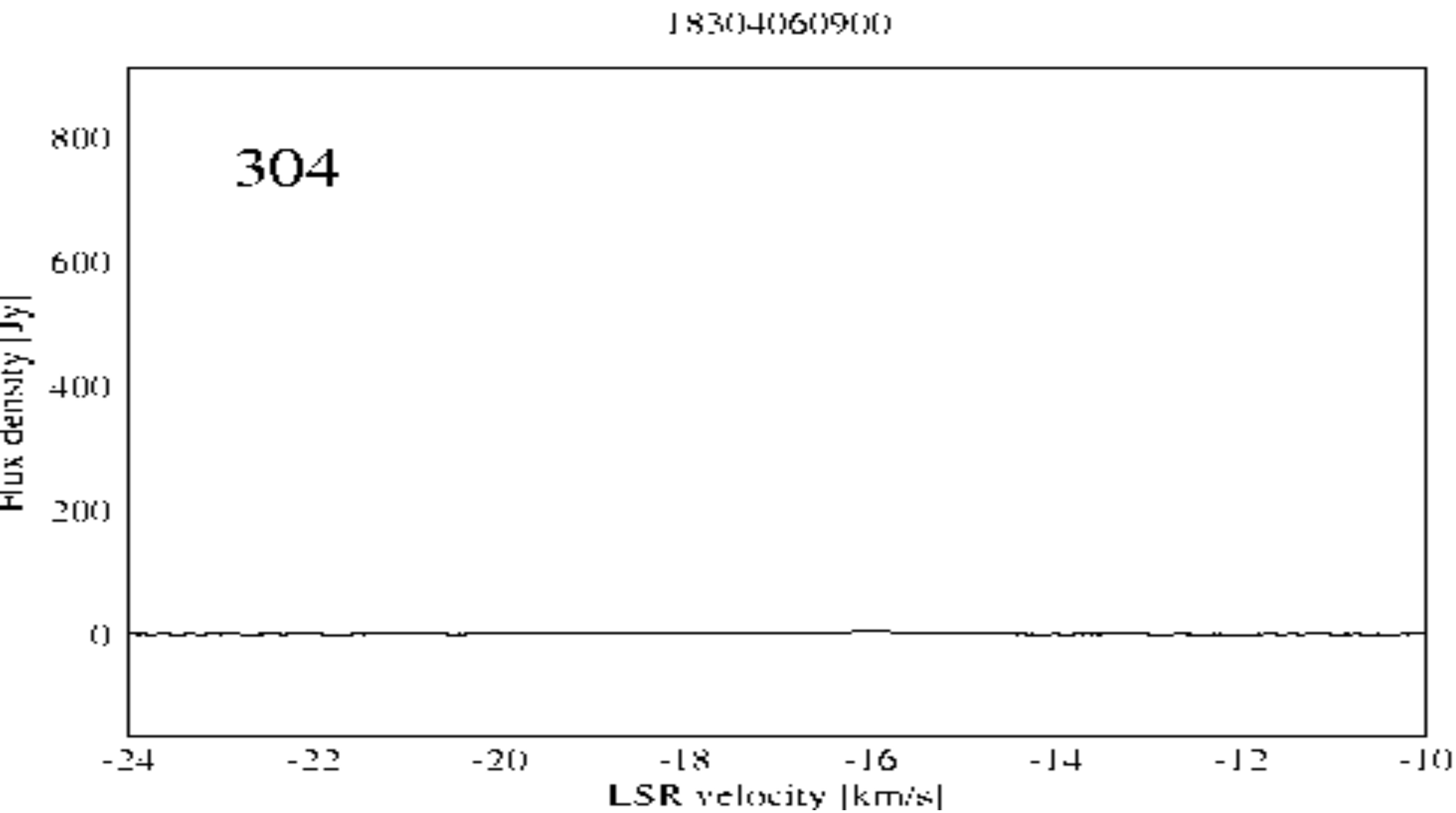


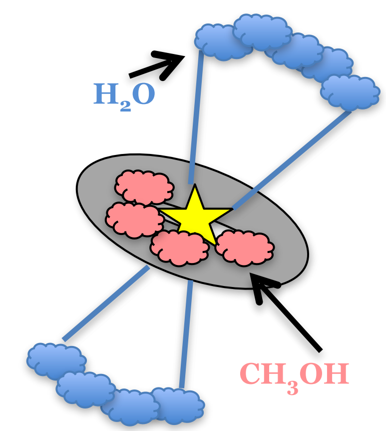
M2O operations



Maser flare: G358.93-0.03

First flare of the 6.7 GHz methanol maser reported to the M2O





Hitachi 32m

Operated by Ibaraki-U

K. Sugiyama alerted the M2O in mid January 2019

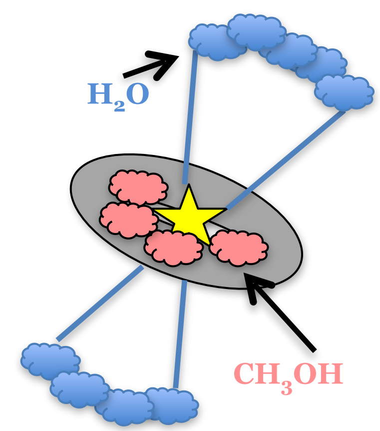
Daily monitoring

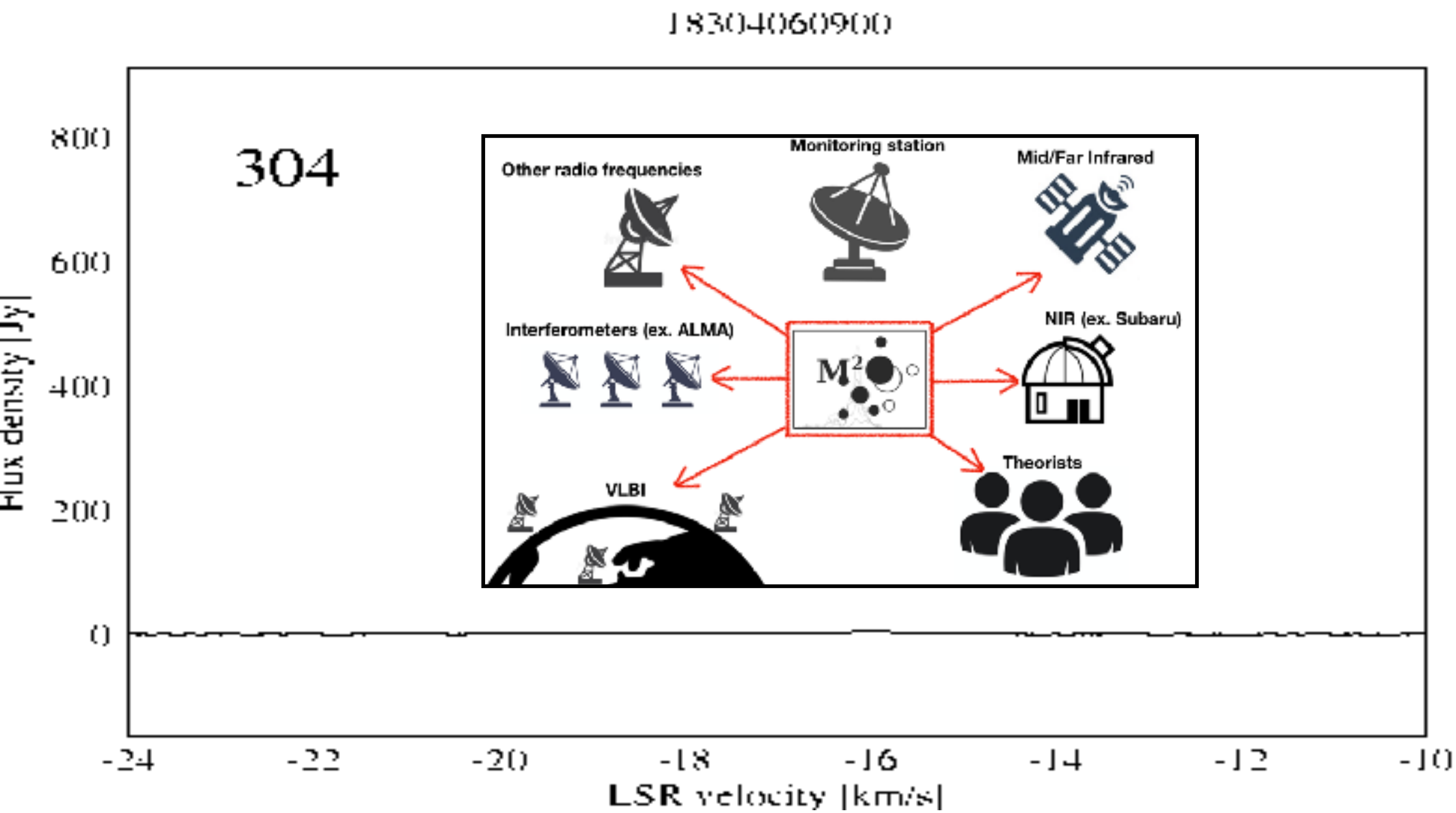
http://vlbi.sci.ibaraki.ac.jp/iMet/G358.9-00-190114/

KS, Y. Yonekura, et al. (2019), ATel

Maser flare: G358.93-0.03

First flare of the 6.7 GHz methanol maser reported to the M2O





Hitachi 32m

Operated by Ibaraki-U

K. Sugiyama alerted the M2O in mid January 2019

Daily monitoring

http://vlbi.sci.ibaraki.ac.jp/iMet/G358.9-00-190114/

KS, Y. Yonekura, et al. (2019), ATel

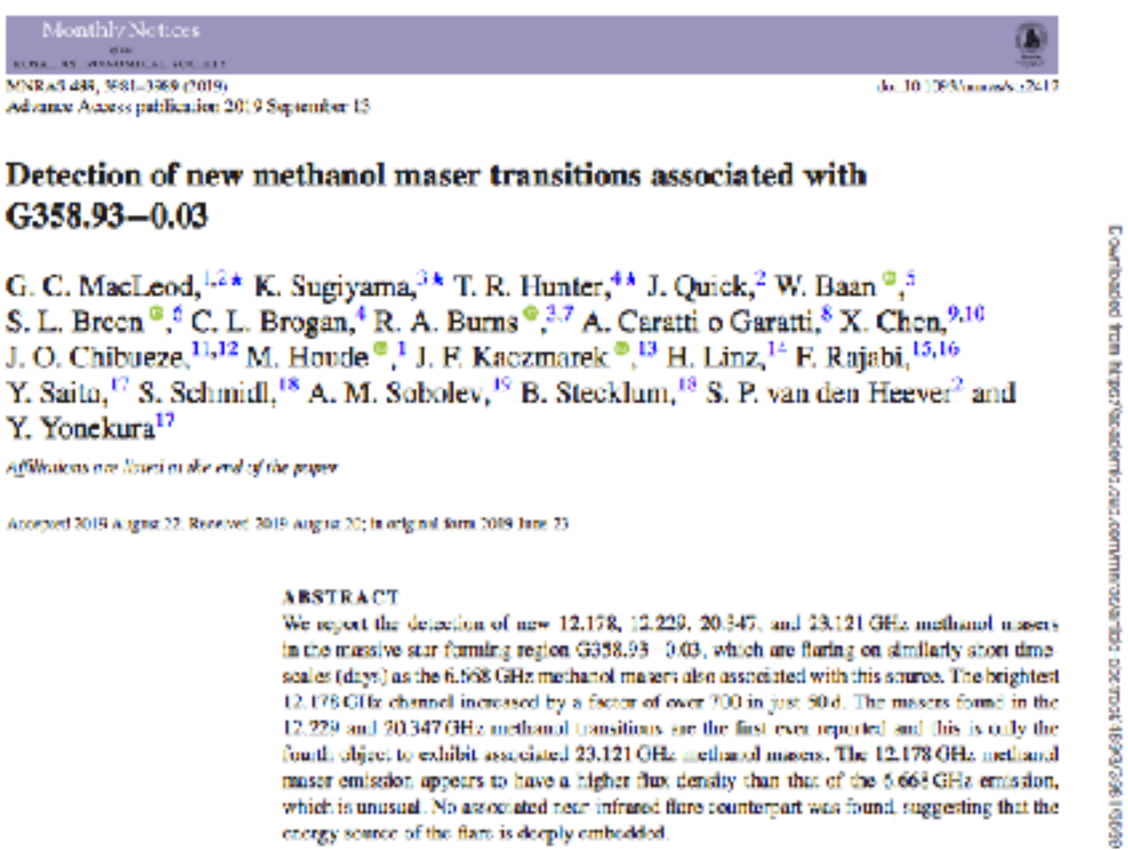
Results from the M2O: Monitoring

Results from the M2O: Monitoring

Burst duration was about 4 months

After the burst the maser stayed brighter than pre-burst

Many new/rare masers were detected


Monthly Notices of the Royal Astronomical Society
MNRAS 488, 3981–3989 (2019)
Advance Access publication 2019 September 15

Detection of new methanol maser transitions associated with G358.93−0.03

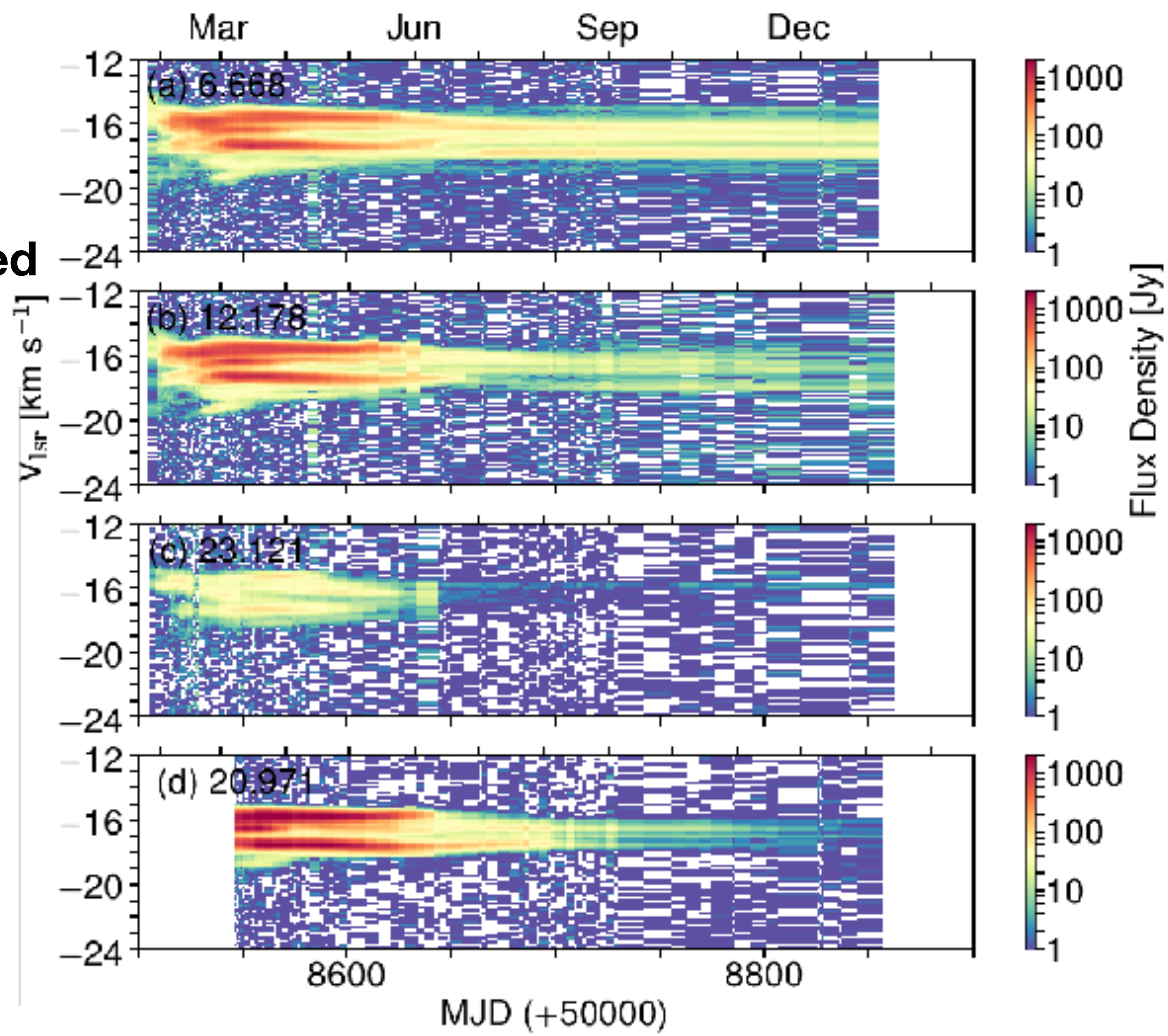
G. C. MacLeod,[1,2★] K. Sugiyama,[3★] T. R. Hunter,[4★] J. Quick,[2] W. Baan,[5] S. L. Breen,[6] C. L. Brogan,[4] R. A. Burns,[3,7] A. Caratti o Garatti,[8] X. Chen,[9,10] J. O. Chibueze,[11,12] M. Houde,[1] J. F. Kaczmarek,[13] H. Linz,[14] F. Rajabi,[15,16] Y. Saito,[17] S. Schmidl,[18] A. M. Sobolev,[19] B. Stecklum,[18] S. P. van den Heever[2] and Y. Yonekura[17]

Affiliations are listed at the end of the paper

Accepted 2019 August 22. Received 2019 August 20; in original form 2019 June 23

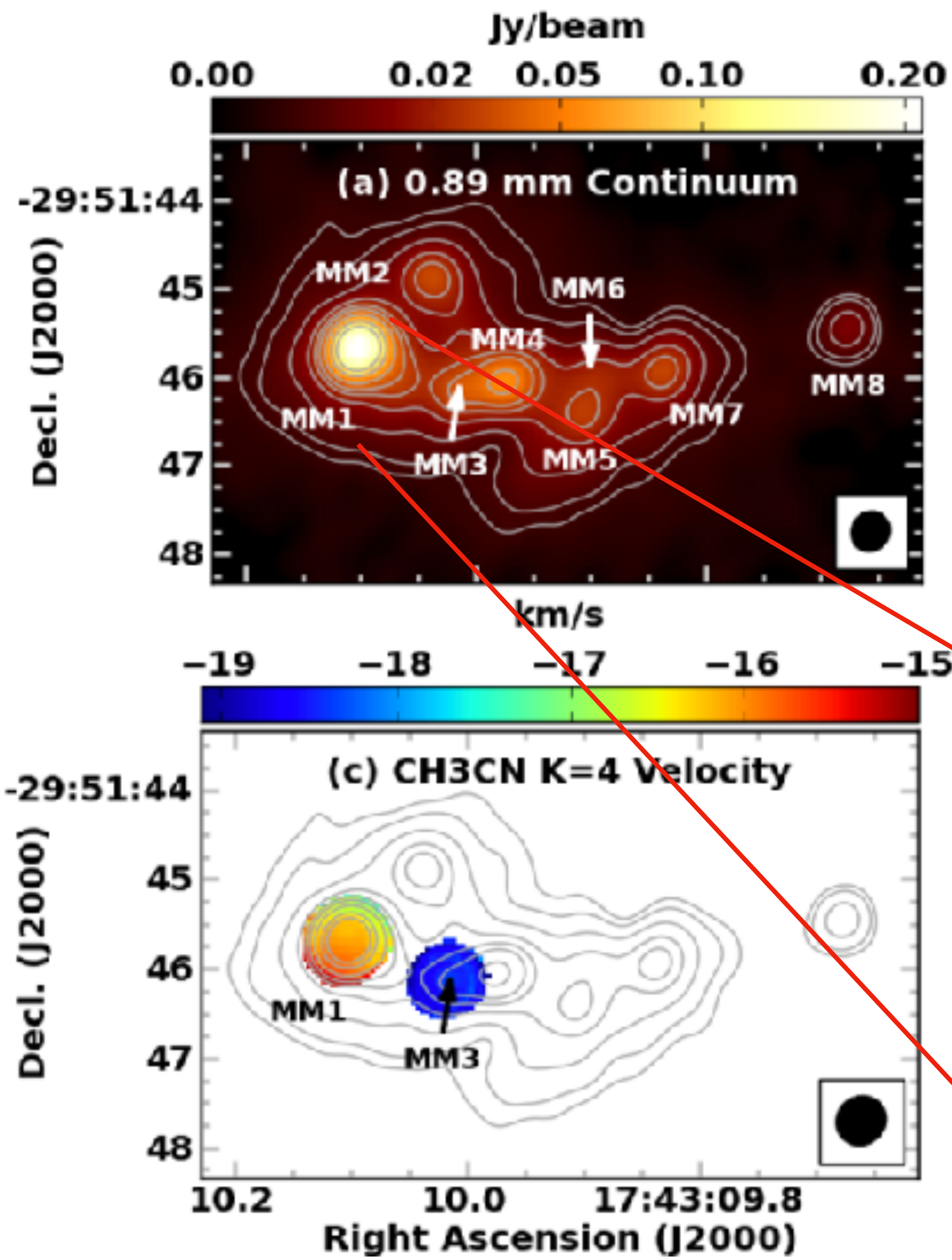
ABSTRACT

We report the detection of new 12.178, 12.229, 20.347, and 23.121 GHz methanol masers in the massive star forming region G358.93−0.03, which are flaring on similarly short time scales (days) as the 6.668 GHz methanol masers also associated with this source. The brightest 12.178 GHz channel increased by a factor of over 700 in just 50 d. The masers found in the 12.229 and 20.347 GHz methanol transitions are the first ever reported and this is only the fourth object to exhibit associated 23.121 GHz methanol masers. The 12.178 GHz methanol maser emission appears to have a higher flux density than that of the 6.668 GHz emission, which is unusual. No associated near infrared flare counterpart was found, suggesting that the energy source of the flare is deeply embedded.



Results from the M2O: ALMA

Results from the M2O: ALMA



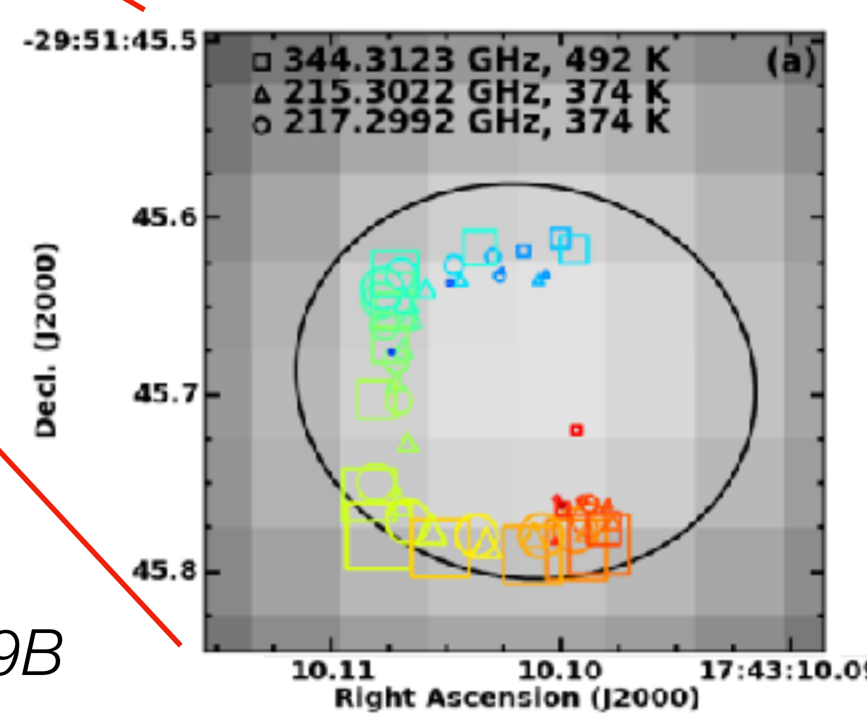
Brogan et al., 2019, ApJ, 881L, 39B

The environment is a cluster

Identified the bursting source: MM1

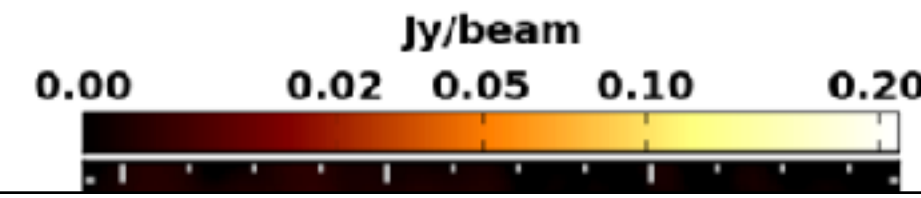
Found 14 new maser transitions,
this implies unusual physics and chemistry

First proof of the torsionally excited maser pumping route



Velocity coherent maser structure ~1200 AU

Results from the M2O: ALMA



The environment is a cluster

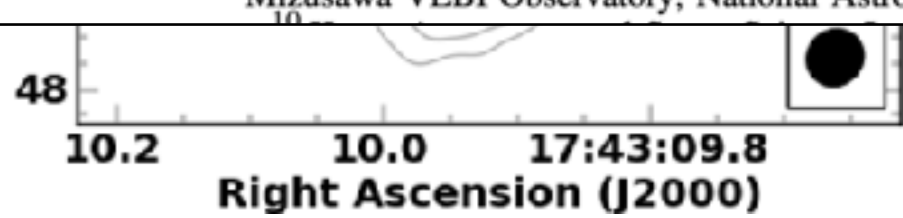
The Astrophysical Journal Letters, 881:L39 (9pp), 2019 August 20 https://doi.org/10.3847/2041-8213/ab2f8a

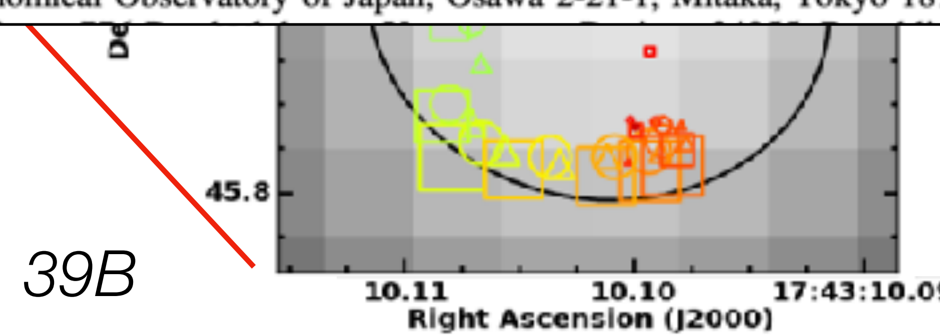
CrossMark

Sub-arcsecond (Sub)millimeter Imaging of the Massive Protocluster G358.93−0.03: Discovery of 14 New Methanol Maser Lines Associated with a Hot Core

C. L. Brogan[1], T. R. Hunter[1], A. P. M. Towner[1,2,27], B. A. McGuire[1,3,28], G. C. MacLeod[4,5], M. A. Gurwell[3], C. J. Cyganowski[6], J. Brand[7,8], R. A. Burns[9,10], A. Caratti o Garatti[11], X. Chen[12], J. O. Chibueze[13,14], N. Hirano[15], T. Hirota[9,16], K.-T. Kim[10], B. H. Kramer[17,18], H. Linz[19], K. M. Menten[17], A. Remijan[1], A. Sanna[17], A. M. Sobolev[20], T. K. Sridharan[3], B. Stecklum[21], K. Sugiyama[22], G. Surcis[23], J. Van der Walt[24], A. E. Volvach[25,26], and L. N. Volvach[25]

[1] National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville, VA 22903, USA; cbrogan@nrao.edu
[2] Department of Astronomy, University of Virginia, P.O. Box 3818, USA
[3] Center for Astrophysics | Harvard & Smithsonian, Cambridge, MA 02138, USA
[4] Hartebeesthoek Radio Astronomy Observatory, P.O. Box 443, Krugersdorp 1740, South Africa
[5] The University of Western Ontario, 1151 Richmond Street, London, ON N6A 3K7, Canada
[6] SUPA, School of Physics and Astronomy, University of St. Andrews, North Haugh, St. Andrews KY16 9SS, UK
[7] INAF-Istituto di Radioastronomia, via P. Gobetti 101, I-40129 Bologna, Italy
[8] Italian ALMA Regional Centre, via P. Gobetti 101, I-40129 Bologna, Italy
[9] Mizusawa VLBI Observatory, National Astronomical Observatory of Japan, Osawa 2-21-1, Mitaka, Tokyo 181-8588, Japan

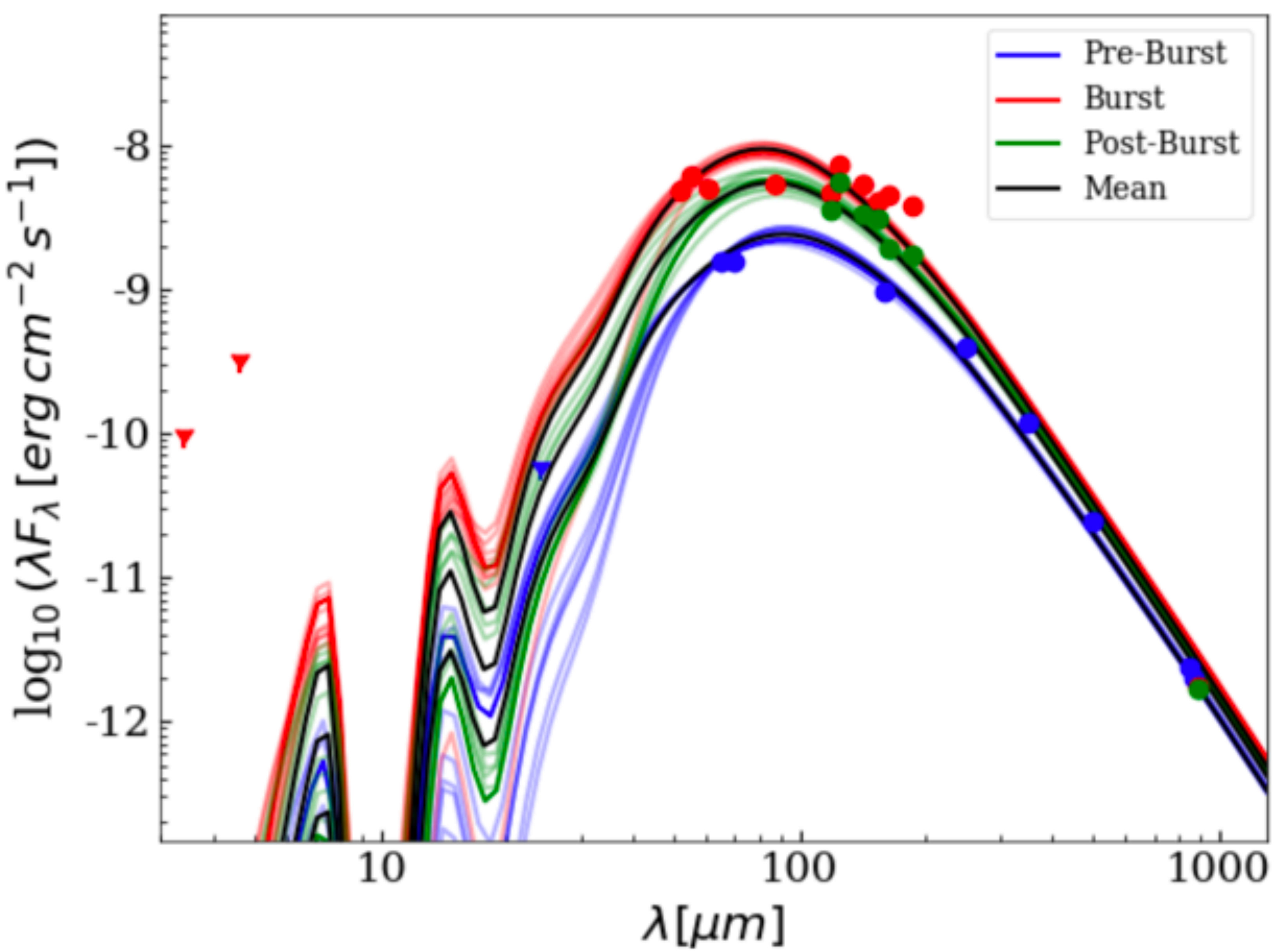




Brogan et al., 2019, ApJ, 881L, 39B

Results from the M2O: SOFIA

Results from the M2O: SOFIA



Stecklum et al. 2020, accepted to A&A
https://arxiv.org/abs/2101.01812

SED shows FIR enhancement

L ~ 5000 Lo
M ~ 10 Mo

Mass accretion rate:

However, since MM1 is likely in an earlier evolutionary stage, preceding the ZAMS, the above assumption may not hold. A different and presumably more realistic approach is possible using the stellar radius from the RT modeling of the pre-burst SED together with the stellar mass of $12 \pm 3\,M_\odot$ derived from the kinematic model of the spiral-arm accretion flows (Chen et al. 2020b). This leads to $M_{acc} = 5.3\,^{+11.1}_{-4.4}\,\times 10^{-4}\,M_\odot$, and $\dot{M}_{acc} = 3.2\,^{+5.4}_{-3.0}\,\times 10^{-3}\,M_\odot yr^{-1}$. The large positive error range is mainly due to the corresponding large uncertainty of the stellar radius. To put this into perspective, during its short burst G358 MM1 consumed about 180 Earth masses. Notably, because of the small disk mass, the accreted fraction represents 16% of the total. This raises the question whether the lightweight disk is a stable or transient feature.

Results from the M2O:

Astronomy & Astrophysics manuscript no. G358-SOFIA
January 7, 2021

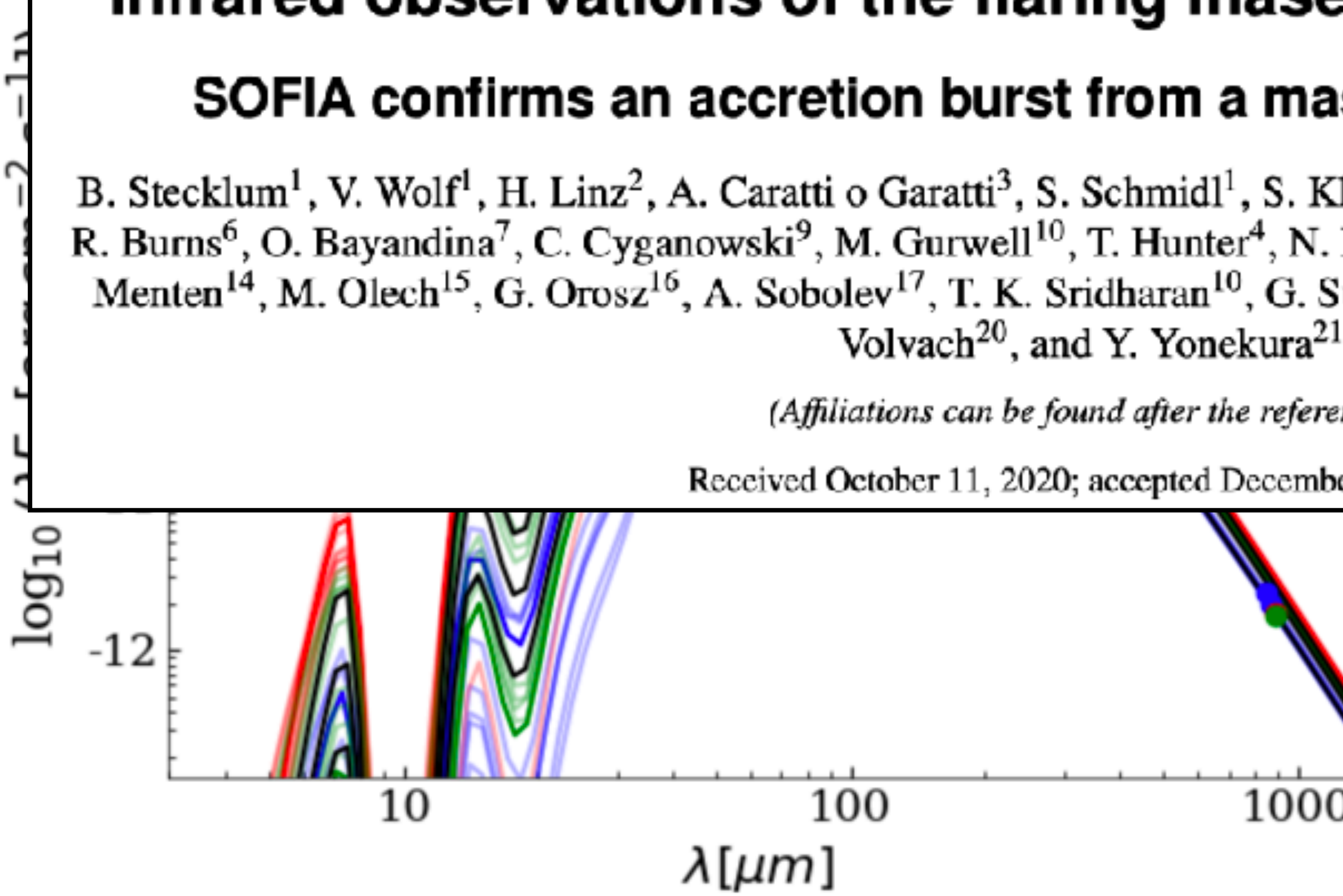
Infrared observations of the flaring maser source G358.93−0.03*

SOFIA confirms an accretion burst from a massive young stellar object

B. Stecklum[1], V. Wolf[1], H. Linz[2], A. Caratti o Garatti[3], S. Schmidl[1], S. Klose[1], J. Eislöffel[1], Ch. Fischer[4], C. Brogan[5], R. Burns[6], O. Bayandina[7], C. Cyganowski[9], M. Gurwell[10], T. Hunter[4], N. Hirano[11], K.-T. Kim[12], G. MacLeod[13], K. M. Menten[14], M. Olech[15], G. Orosz[16], A. Sobolev[17], T. K. Sridharan[10], G. Surcis[18], K. Sugiyama[6], J. van der Walt[19], A. Volvach[20], and Y. Yonekura[21]

(Affiliations can be found after the references)

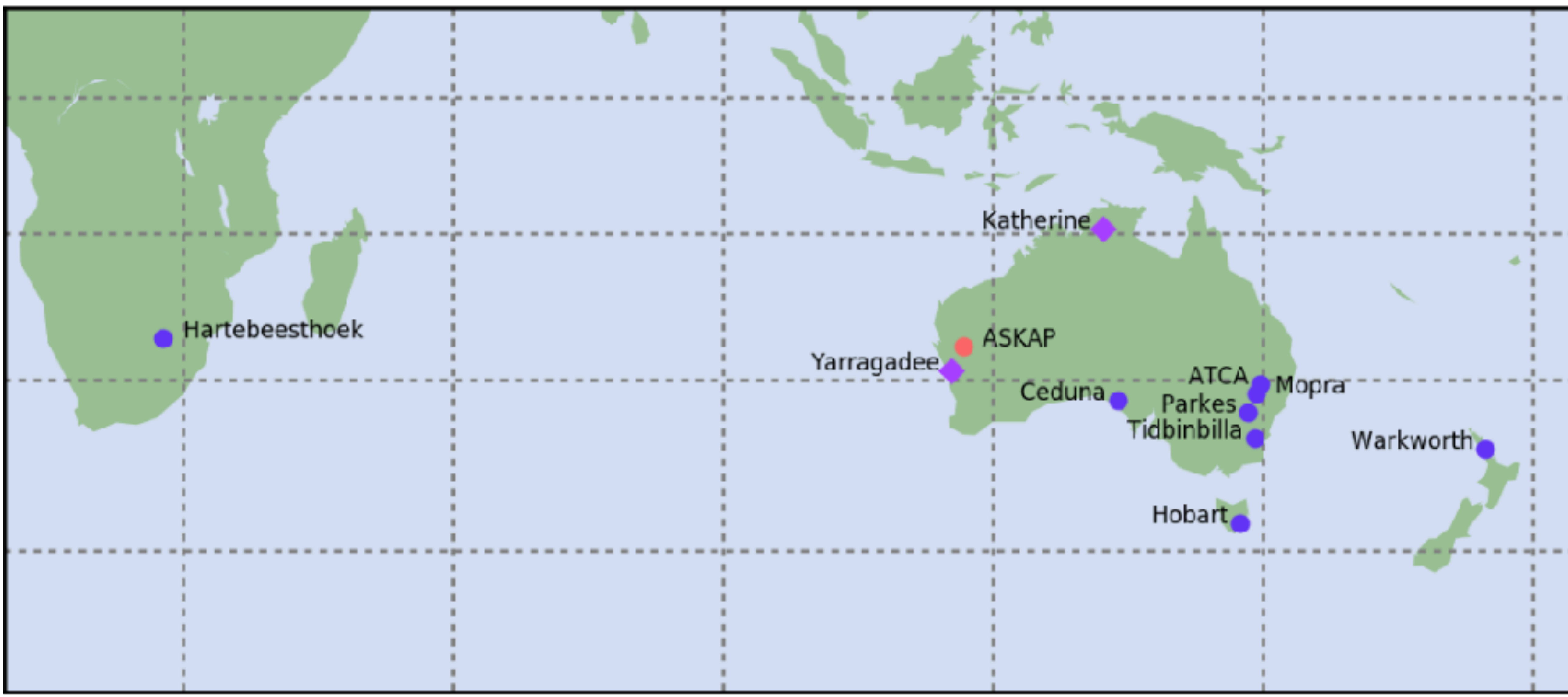
Received October 11, 2020; accepted December 21, 2020

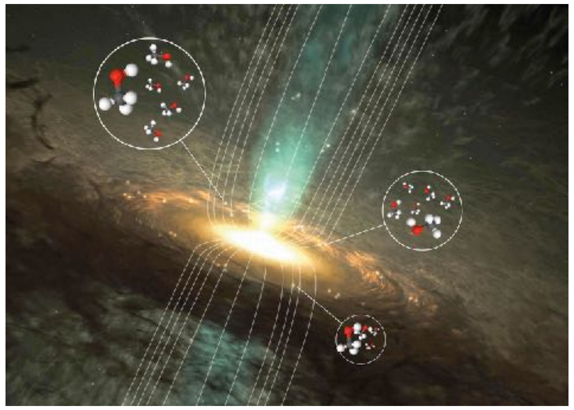


et al. 2020b). This leads to $M_{acc} = 5.3^{+11.1}_{-4.4} \times 10^{-4}\,M_\odot$, and $\dot{M}_{acc} = 3.2^{+5.4}_{-3.0} \times 10^{-3}\,M_\odot yr^{-1}$. The large positive error range is mainly due to the corresponding large uncertainty of the stellar radius. To put this into perspective, during its short burst G358 MM1 consumed about 180 Earth masses. Notably, because of the small disk mass, the accreted fraction represents 16% of the total. This raises the question whether the lightweight disk is a stable or transient feature.

Stecklum et al. 2020, accepted to A&A
https://arxiv.org/abs/2101.01812

Results from the M2O: VLBI (LBA)





VLBI images of methanol masers during an accretion burst

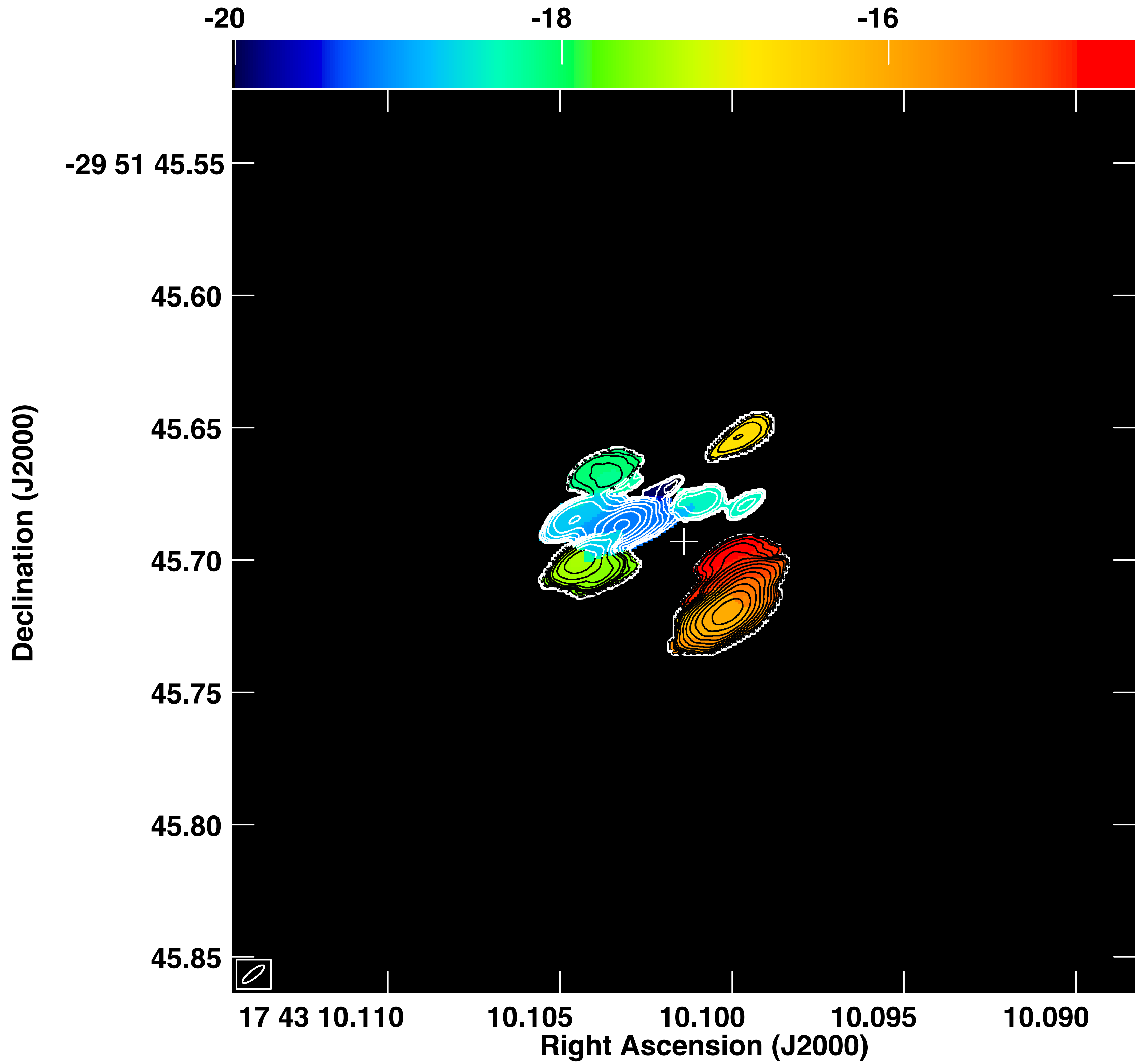
<u>G358-MM1</u>
High-mass protostar which underwent an accretion burst in 2019

Beamsize:
10 x 3 mas

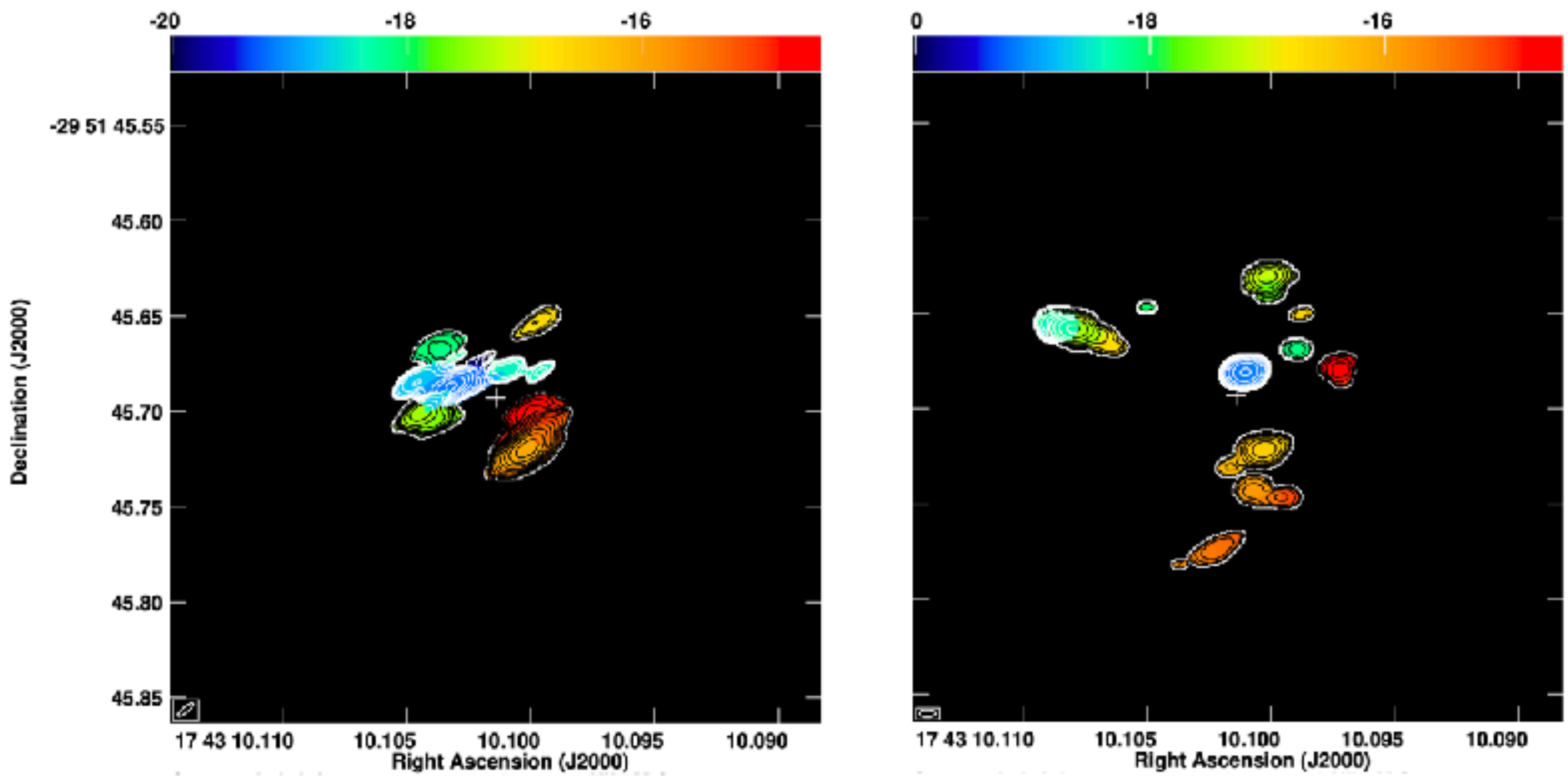
Contours:
MOM0
(flux density)

Colours:
MOM1
(Velocity [km/s])

White cross:
ALMA mm core



Results from the M2O: VLBI (LBA)



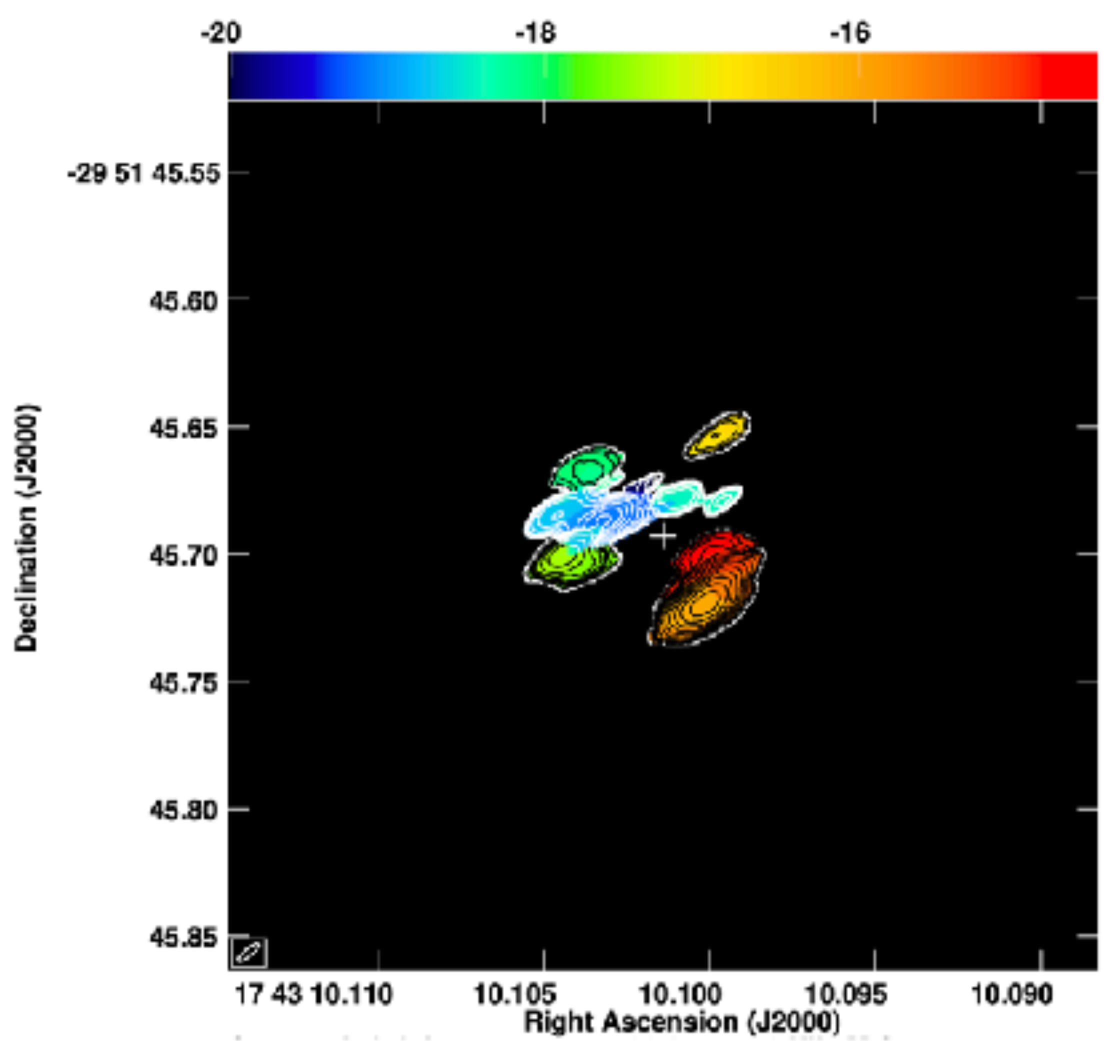
Burns et al., 2020, Nature Astronomy, vol 4, 506

- **Implies a translocation of 1-2 mas/day, which is 11,700 to 23,400 km/s at the source's kinematic distance of 6.75 kpc (equivalent to 0.04 to 0.08c).**

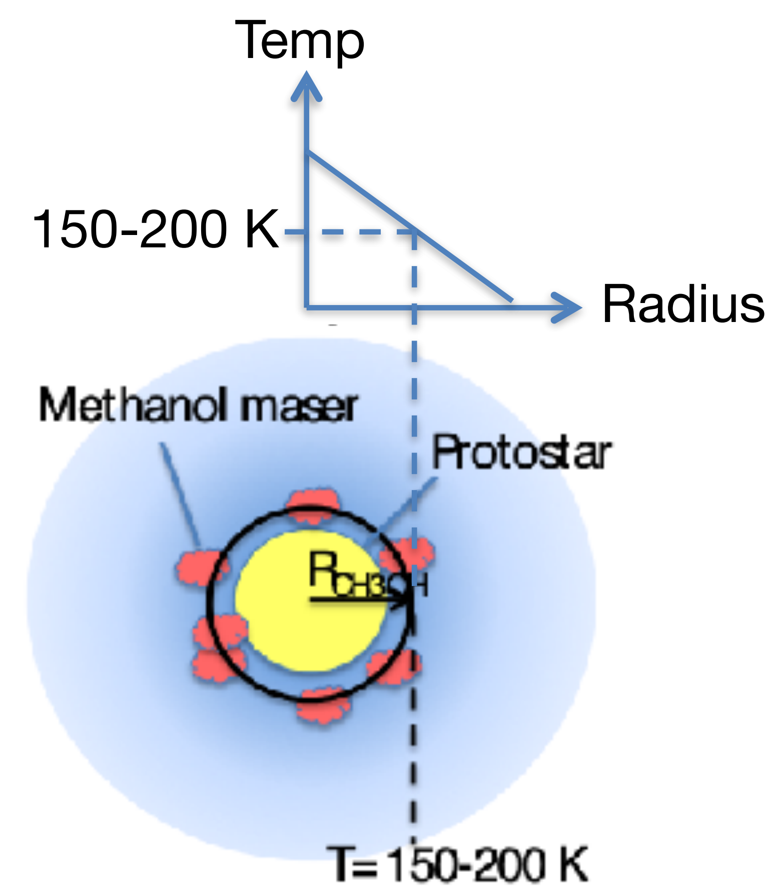
- **Methanol masers die at v >10 km/s i.e. Too fast to be proper motion.**

Results from the M2O: VLBI (LBA)

- **Compact (260 au @ 6.75 kpc)**
- **Ring-like**
- **Center on MM1 (Brogan+ 19)**



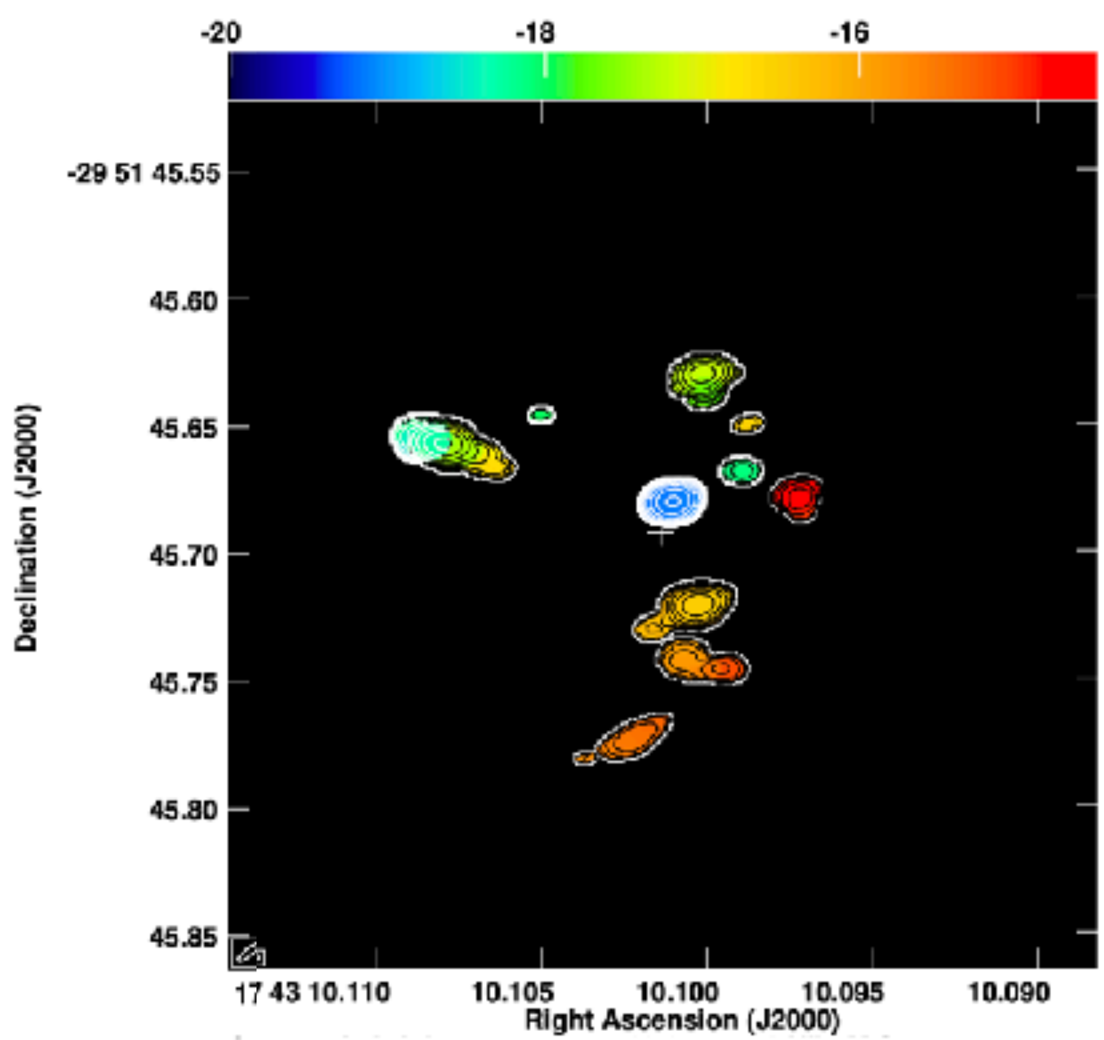
Interpretation



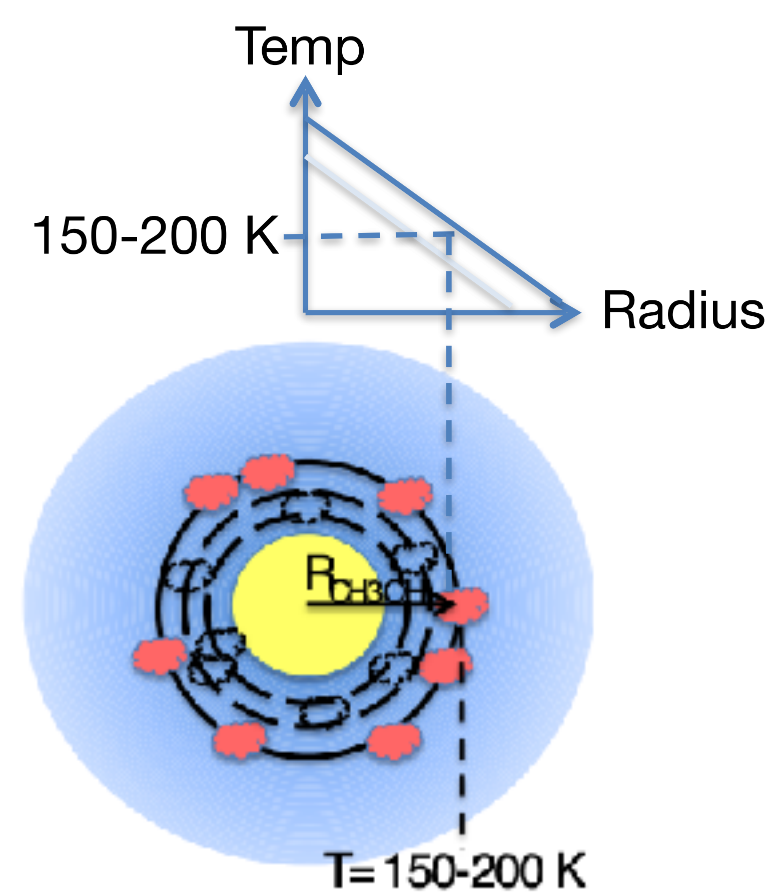
Burns et al., 2020, Nature Astronomy, vol 4, 506

Results from the M2O: VLBI (LBA)

- **Compact (260 au @ 6.75 kpc)**
- **Ring-like**
- **Center on MM1 (Brogan+ 19)**



Interpretation



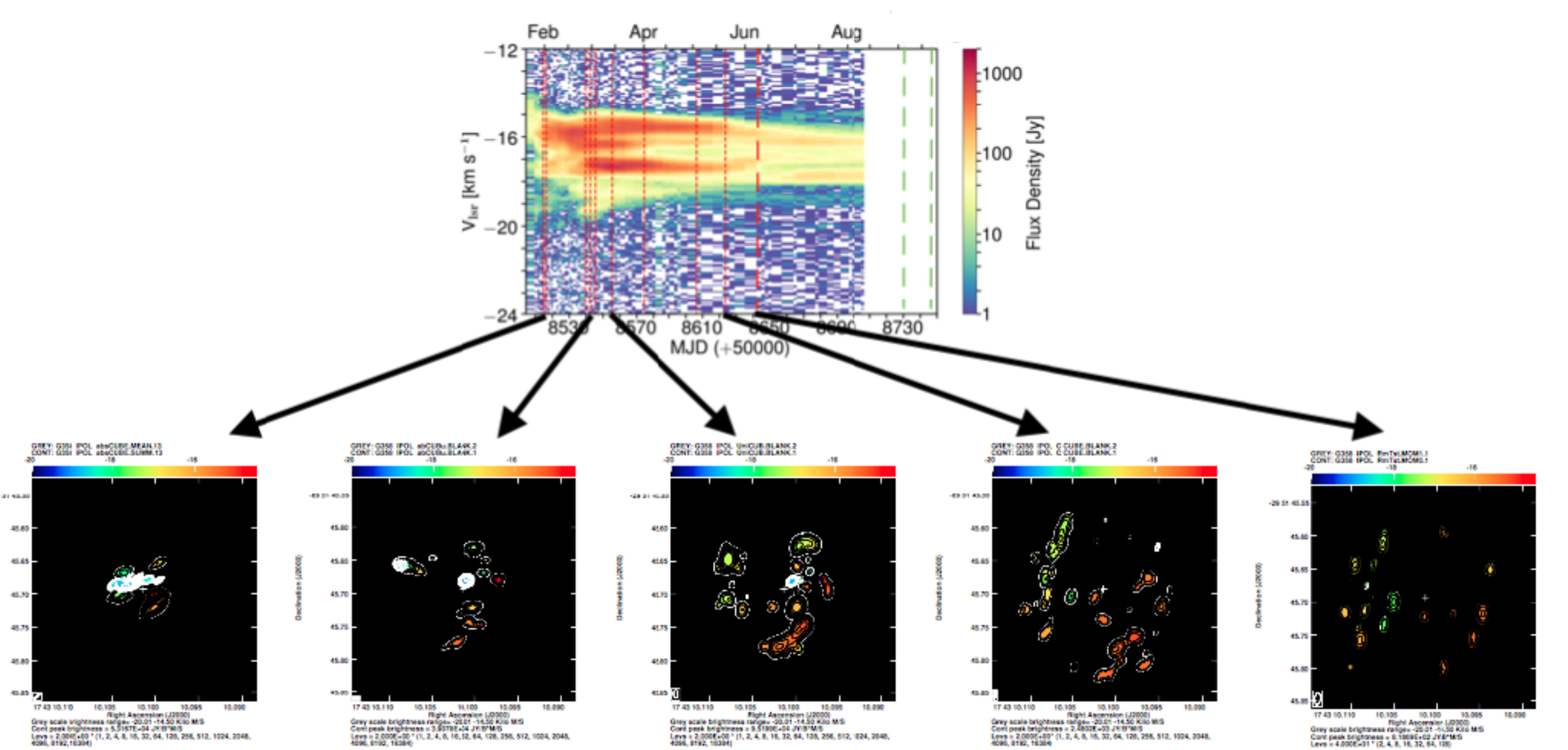
Masers trace a "heat-wave" of accretion energy propagating outward.

Burns et al., 2020, Nature Astronomy, vol 4, 506

Results from the M2O: VLBI (Combined)

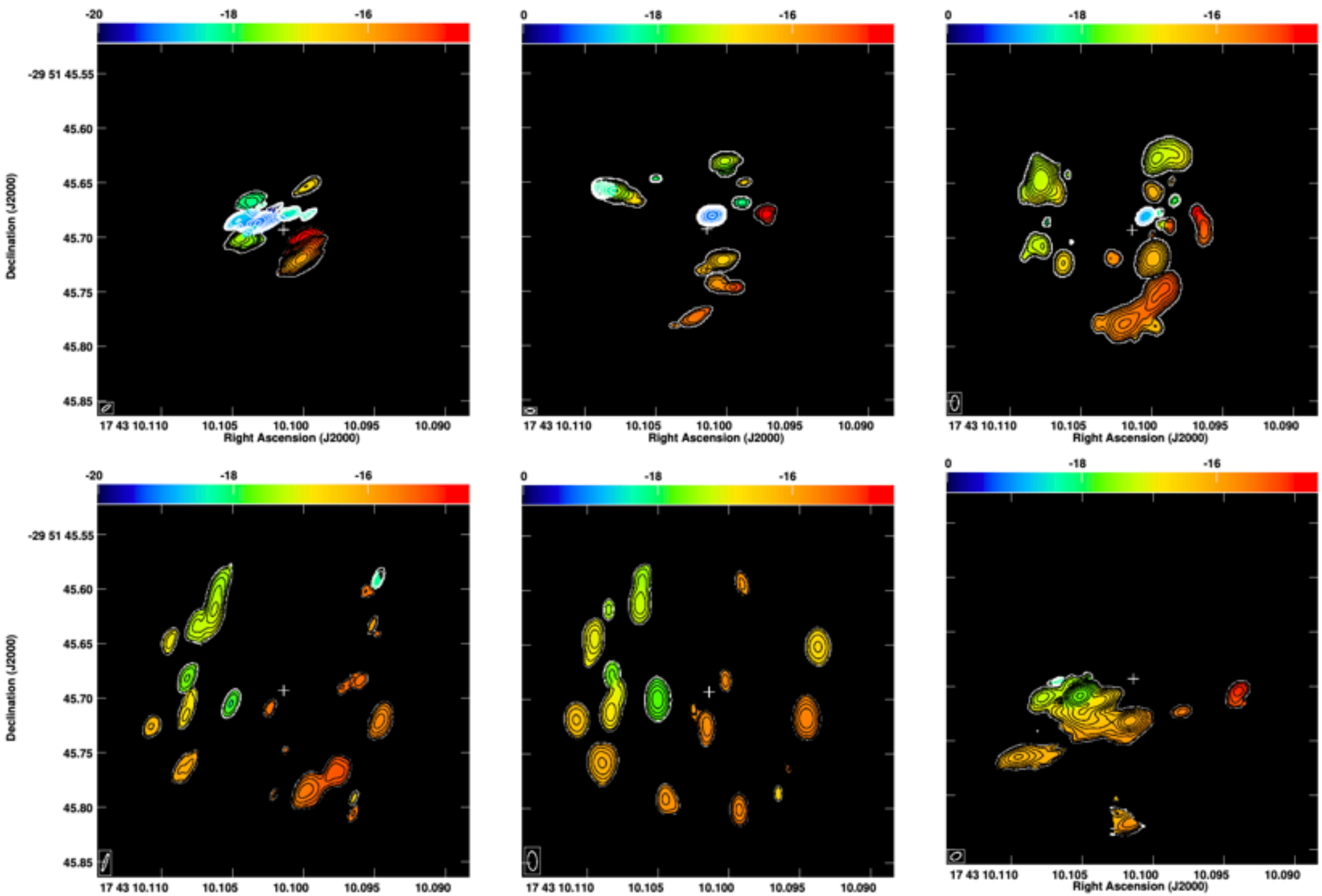
LBA, EVN, VLBA

Results from the M2O: VLBI (Combined)



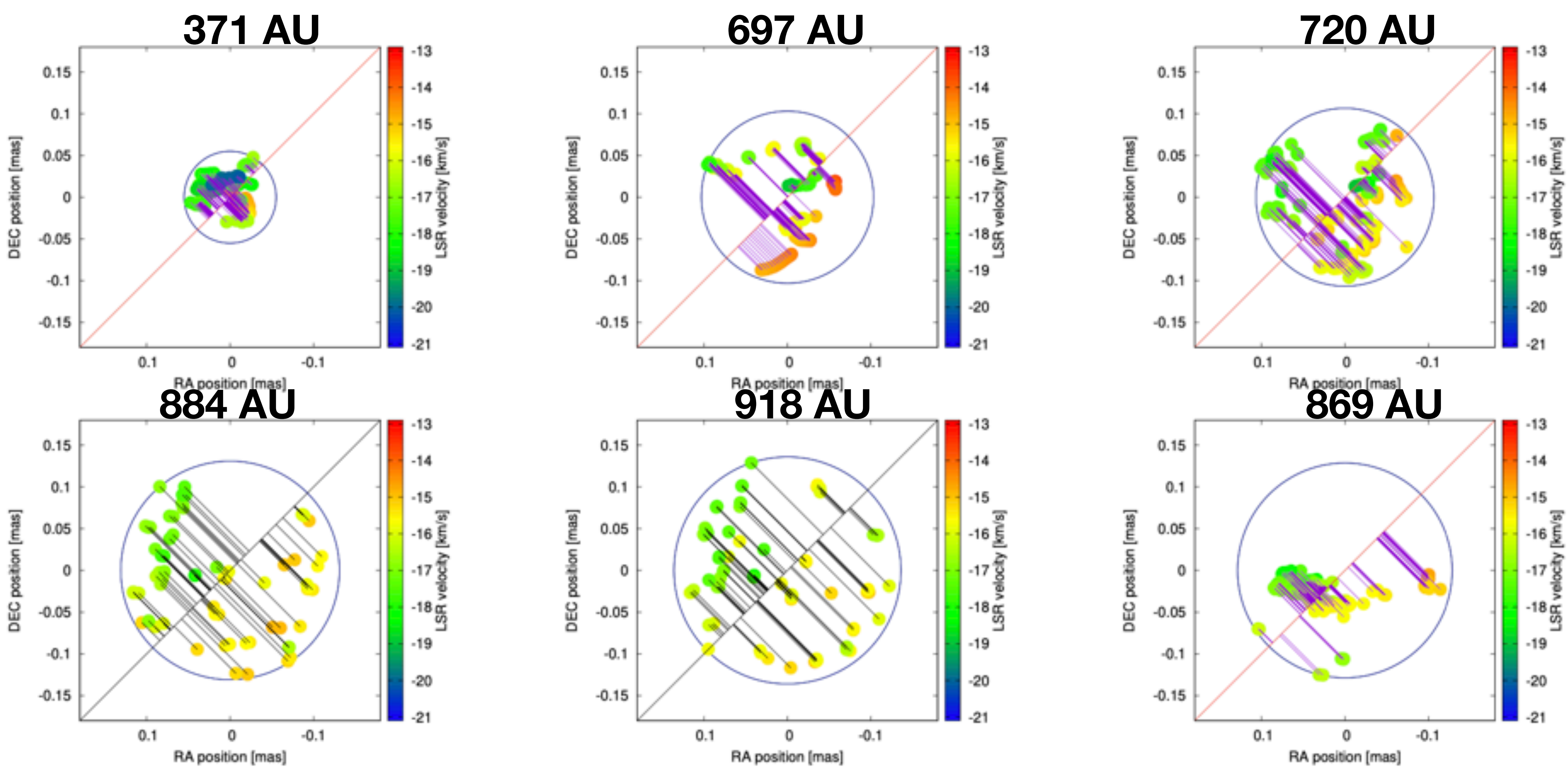
LBA **LBA** **EVN** **VLBA** **VLBA**

Results from the M2O: VLBI (Combined)

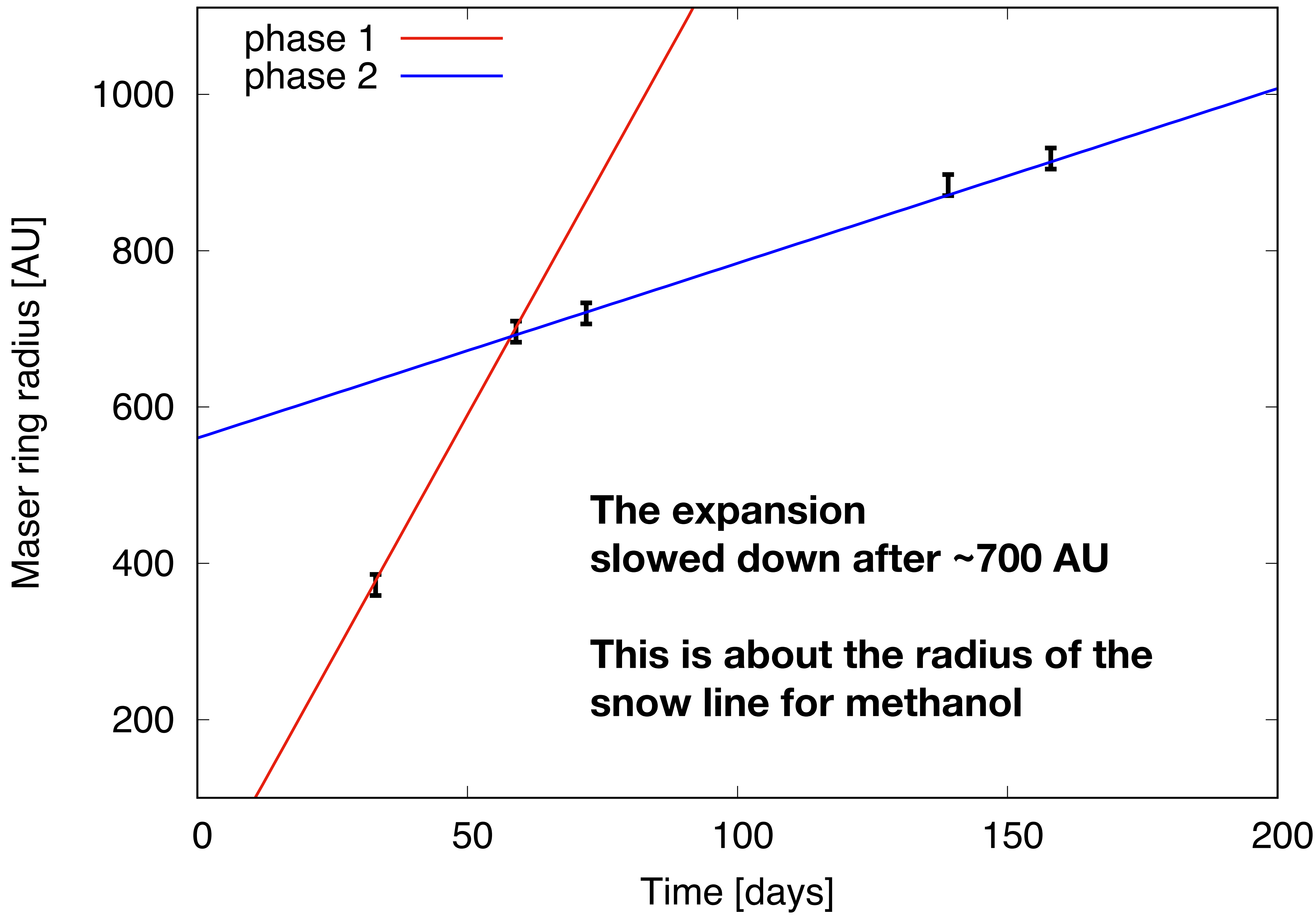


Eventually the ring of masers disappeared

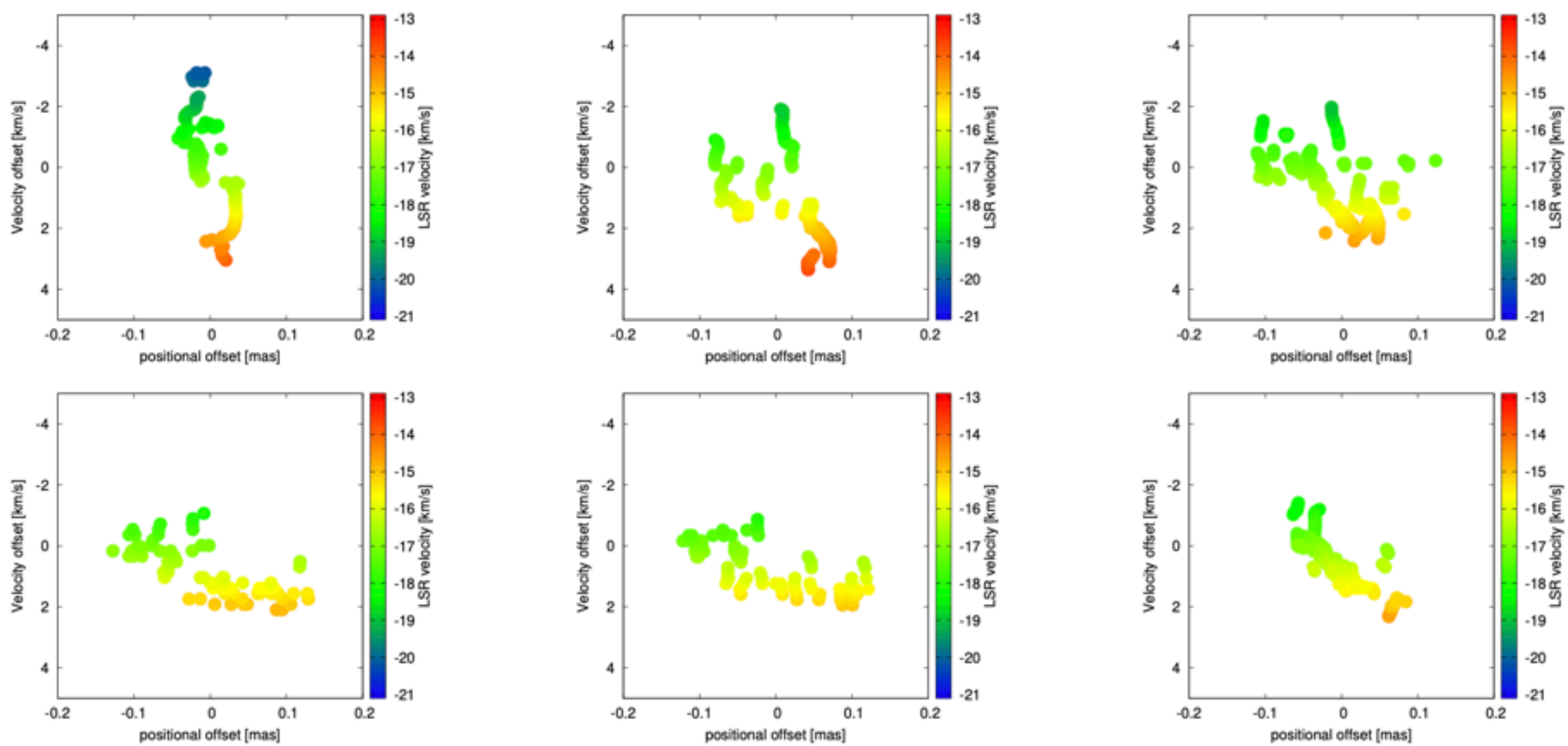
Results from the M2O: VLBI (Combined)



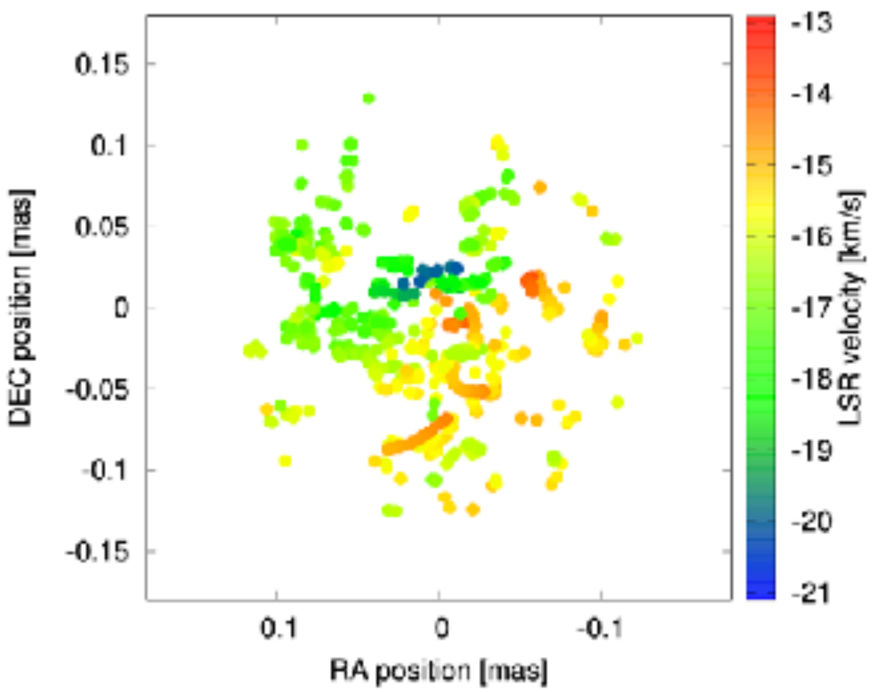
Results from the M2O: VLBI (Combined)

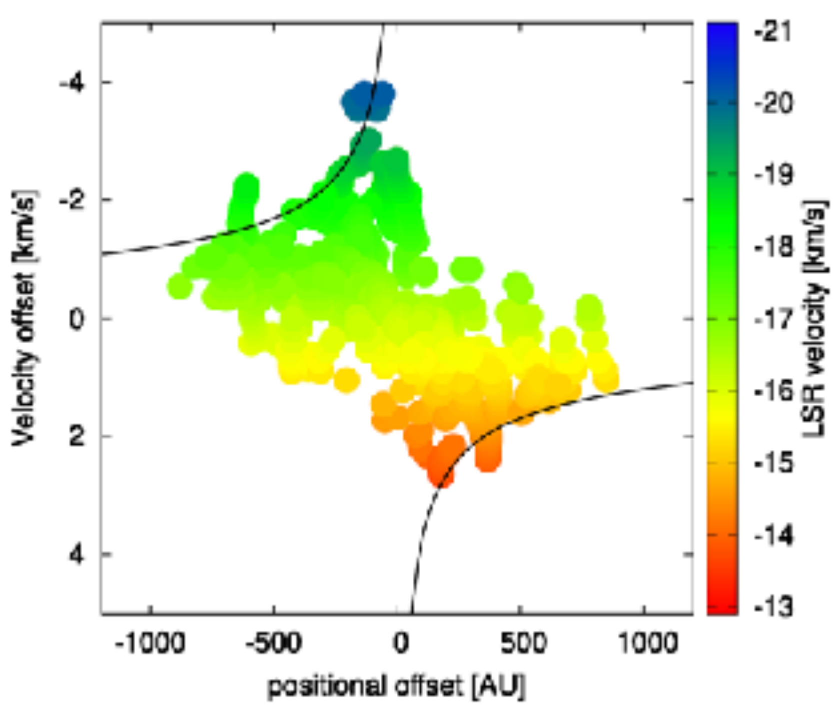


Results from the M2O: VLBI (Combined)



Results from the M2O: VLBI (Combined)





We can see the suggestion of spiral arms or accretion flows in the combined image

The combined PV diagram shows the signature of an inflating Keplarian disk

The dynamic mass is estimated to be 1.6 Mo, However we know the true mass is ~10 Mo from SED analyses, this means the system is face-on.

The combined M2O data set gives the most detailed picture of an accretion burst in a high-mass protostar

What we learned from the G358 maser flare

Regarding high-mass star formation

- **Strongest evidence yet for episodic accretion in high mass star formation**
- **Accretion events show variety (S255-IR, NGC6334, G358)**
- **Accretion events give rise to exotic maser emission (need new models)**
- **Disks show structure / clumsiness, consistent with epi. acc. theory**

Regarding M2O operations

- **The 6.7 GHz methanol maser readily identifies accretion events**
- **Is also easy to monitor with radio telescopes**
- **Our operations model for flare alerts and collaborations works**
- **Multi-wavelength and multi-epoch follow-up observations needed**
- **Collaboration (Radio, mm, NIR, MIR, FIR, etc.)**

Triggerable Target of Opportunity proposals are necessary to catch bursts

Activities after the G358 maser flare

Expanded observing resources

More radio telescopes monitoring

More partners specialising in a wide range of facilities

M2O follow-up data

No.	Target	Facility	Date	Frequency (GHz)	Code	PI/comment
1	G25	VLA	Oct 2017	6.7, 12.2, 22	17B-408	OB / Reduced
2	G25+W49N	EVN	Oct 2017	22	RB004	RB / Reduced
3	G25+W49N	KaVA	Oct 2017	22	K17RB01A	RB / Reduced
4	G25+W49N	VLBA	Oct 2017	22	BO058	GO / Reduced
5	G25	VERA	2007-2013	22, 16 x epochs	[archival]	K. Motogi / Processing
6	G358	VERA	31 Jan 2019	6.7	-	SY / Reduced
7	G358	VERA	3 Mar 2019	6.7	-	SY / Reduced
8	G358	VERA	1 Apr 2019	6.7	-	SY / Reduced
9	G358	VERA	3 May 2019	6.7	-	SY / Reduced
10	G358	LBA	2 Feb 2019	6.7	vc026a	RB / Reduced
11	G358	LBA	3 Feb 2019	23.1	vc026b	GO / Abandoned
12	G358	LBA	28 Feb 2019	6.7	vc026c	RB / Reduced
13	G358	EVN	13 Mar 2019	6.7, 6.18	RB005	RB / Reduced
14	G358	KVN	25 Mar 2019	22, 44, 95, 120	n19rb01a	RB / Reduced
15	G358	VLBA	19 May 2019	6.7, 12.2, 23.1	BB414	RB / QuickLook
16	G358	VLBA	7 Jun 2019	6.7, 12.2, 20.7	BB412	RB / Reduced
17	G358	LBA+E.Asia	17 May 2019	7.6, 7.8	vx028a	GO,SE / QuickLook
18	G358	LBA+AusSCOPE	28 Sep 2019	6.7	v581a	RB / Reduced
19	G358	SOFIA	30 April 2019	50...120 μm		BS,JE
20	G358	GROND	8 Feb 2019	NIR		HL,BS,AC
21	G358	SMA	several 2019	mm		THunter,CB
22	G358	ALMA	several 2019	Bands 5,6,7		CB
23	G358	VLA	2019	GHz	-	OB
24	G358	VLA	2019	GHz	-	OB
25	G358	VLA	2019	HNCO	-	XC,AS
26	G24	LBA	8 Sep 2019	6.7	vx026d	RB,MO / Correlated
27	G24	LBA	13 Sep 2019	6.7	s002a	RB,MO / Correlated
28	G24	LBA	28 Sep 2019	6.7	v581a	RB,MO / Correlated
29	G24	EVN	22 Sep 2019	22	RB006A	RB,MO / QuickLook
30	G24	EVN+Merlin	7 Oct 2019	6.7	RB006B	RB,MO / QuickLook
31	G24	EVN+Merlin	17 Nov 2019	1.667	RB007	RB,MO / correlated
32	G24	VLBA	27 Sep 2019	6.7, 12.2, 22	BB416A	RB,MO / QuickLook
33	G24	VLBA	27 Oct 2019	6.7, 12.2, 22	BB416B	RB,MO / correlated
34	G24	VLBA	02 Dec 2019	6.7, 12.2, 22	BB416C	RB,MO / correlated
35	G24	ALMA	26 Sep 2019	Band6	-	THirota / QuickLook
36	G24	SOFIA	25 Oct 2019	FIR		BS,JE
37	G24	ATCA	26 Nov 2019	K-band	C3321	GO,SB
38	G24	ATCA	27 Nov 2019	C-band	C3321	GO,SB
39	NGC2071, Ori-S6	KaVA	13 Mar 2020	22/44/95/130	a20d3a	RB / QuickLook
40	NGC2071, Ori-S6	KaVA	16 Apr 2020	22/44/95/130	a20d3b	RB / QuickLook
41	NGC2071, Ori-S6	KaVA	11 May 2020	22/44/95/130	a20d3c	RB / Correlated
42	G85	VLBA	24/Apr/2020	L/C/Ku/K	BB421B	RB / QuickLook
43	G85	VLBA	22/May/2020	L/C/Ku/K	BB421A	RB / QuickLook
44	G85	VLBA	22/June/2020	L/C/Ku/K	BB421C	RB / correlated
45	G359.617-0.251	LBA	18?Aug/2020	6.7	V581A	RB / Observed
46	G359.617-0.251	VLBA	21/Aug/2020	6.7 / 12.2 / 22	BB418A	RB / Correlated
47	G359.617-0.251	ATCA	25-26/July/2020	6-10 GHz	C3321	GO / Processing
48	G034.196-0.592	VLA	19/NOV/2020	C	VLA/20B-441	DL / Processing
49	G034.196-0.592	VLA	29/NOV/2020	K	VLA/20B-441	DL / Processing

<u>Triggerable ToO proposals:</u>

EVN

KaVA

LBA

VLBA

Subaru

Activities after the G358 maser flare

More members
(Currently 71)

More publications
(Currently 16 published or accepted)

More maser flares

- **M2O targets:**

Name	Maser [GHz]	Pre-burst Flux [Jy]	Max Flux [Jy]	Current Flux [Jy]	Reported by	Reobserved by	Status
G359.617-0.251	6.7	120	200	150	Yonekura	Ib, Hh,	decreasing
Orion S6	6.7	3.1	9	4	Yonekura	Ib, Tr, Sz, Hh	stable
G85.411+0.002	6.7	12	95	110	Yonekura	Ib, Ef, Sz, Tr, Hh, Ky, Vs	rising
G33.641-0.228	6.7	-	236	236	Bringfried	Hh, Ib, Vs	eruptive
IRAS 16293-2422	22	-	30k	-	Sunada, Mc	Vr, Mc, Hh, Sz, Ib	-
NGC2071	22	1k	7k	920	Sunada, Hh	Vr, Hh, Sz, Ib	post-burst
G53.22-0.08	22	3	800	30	Sunada	Vr, Hh, Ib	post-burst
G358.93-0.03	6.7	5	1000	20	Yonekura	Hh, Ib	decreasing
G24.33+0.14	6.7	-	800	8	Torun	Hh, Ib, Vs	decreasing
G25.65+1.05	22	-	60k	2150	Sz	Hh, Sz	post-burst
G034.196-0.592	22	-	120	120	Ladeyschikov	Sz, Oa, Hh	rising

(Ib = Ibaraki) (Tr = Torun) (Sz = Simeiz) (Hh = HartRAO) (Ef = Effelsberg) (Ky = KVN Yonsei) (Vs = Ventspil) (Vr = VERA stations) (Mc = Medicina) (Ps = Puschino) (Oa = OAO-WFC)

Our interests are not restricted to high-mass star formation.

We are always looking for more ways to collaborate and use transient maser emission as tracers for astrophysical processes

Thank you for listening