M2O Telecom, No. 18

The main news items this month:

Papers: Progress in several papers (Stecklum et al., Hirota et al.)
New proposals: Several submitted (JWST, EAVN, KaVA, VLA), these will be discussed individually.
Maser flares: Water maser flare in G034.196-0.592 progress on maser localisation (6.7 and 22 GHz, VLA)
G358 6.7 GHz VLBI: Some progress with data reduction [see Reports]
Irbene single baseline interferometer resuming operations
MaserDB updated

1 Activity since the previous Newsletter

- **SamePage:** total 69 members.
- **Papers accepted:** +0; Total: 15
- **Papers in revision:** +1 (Stecklum et al.)
- **Updates on papers in prep:**
  - Bayandina et al., VLA masers in G358
  - Burns et al., 6.7 GHz VLBI movie in G358. **Drafting** and further analyses (see Reports)
  - Burns et al., VLBI maps of rare maser lines in G358. Images circulated during telecom 15
  - Orosz et al., 7.6 and 7.8 GHz methanol masers in G358, aiming for ApJL
  - Hirota et al., ALMA follow-up of G24.33+0.14 in pre- and post- maser flare phases. **Internal rev.**
  - Olech et al., VLBI images of G24.33 during its maser flare.
  - Stecklum et al., SOFIA, radiative transfer analyses of the G358 burst. **In revision (A&A)**
  - Gray et al., Two additions to the maser flare series: compression and overlap.

- **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)

- **New observing proposals:**
  James Webb Space Telescope: Triggered ToO. NIR, MIR, ∼0.1” res, 4 epochs of 6hrs. Requesting spectral (accretion tracers, snow lines) and continuum observations of accreting MYSOs (PI: Carratti o Garatti)
  VLA DDT G034.196-0.592. Observations of 6.7 and 22 GHz masers. (PI: Ladeyschikov)
  KaVA Triggerable ToO at K/Q/W/D (PI: Burns)
  EAVN Triggerable ToO at 6.7 GHz to trace accretion driven flares (PI: Burns)

- **Active trigger proposals:**

Array	Code	Grade	Hours granted target x epoch x hour	Hours remaining	Active period	Resubmit deadline
EVN	EB083	1.2 / 5.0 (0 is best)	(3x2x8)x2 bands = 96	96	15/SEP/20 - 15/SEP/21	01/JUN/20
KaVA	EAVN20B-183	7.2 / 10.0 (10 is best)	2 x 3 x 8 = 48	48	01/Sep/20 - 01/Feb/21	2/NOV/20
LBA	V581	4.0 / 5.0 (5 is best)	96	88	01/OCT/19 - 01/OCT/20	16/JUN/20
VLBA	BB418	1.82 / 10.0 (0 is best)	48	48	01/AUG/20 - 01/AUG/21	01/FEB/21
Subaru	S20B0051N	accepted	0.5*2 or 1 night	0.5*2 or 1 night	01/AUG/20 - 01/JAN/21	-

- **Follow-up observations conducted this month (see Record Keeping):**
  VLA DDT of G034.196-0.592 22 GHz maser flare, observed at 6.7 and 22 GHZ.

Record keeping

3 M2O Publications

No.	Target	Facility	Author	Frequency (GHz)	Status	Ref	Journal
1	W49N	Sm, Tr	Volvach+	22.2	Published	(1)	MNRAS_L
2	W49N	Sm, Tr, Mc, Ef	Volvach+	22.2	Published	(2)	A&A
3	W49N	Sm, Tr, Mc, Ef, Kvazar	Volvach+	22.2	Published	(3)	Ast.Rep.
4	W49N	Sm	Volvach+	22.2	Published	(4)	MNRAS
5	G25	VLA	Bayandina+	6.7, 12.2, 22	Published	(5)	ApJ
6	G25	Sim/Hh/Tr	Volvach+	22	Published	(6)	MNRAS_L
7	G25	KVASAR	Volvach+	22	Published	(7)	Ast.Rep.
8	G25	EVN	Burns+	22	Published	(8)	MNRAS
9	G25		Aberfelds+	6.7	in prep		-
10	G25		Bayandina+	12.2, 23.1	in prep		-
11	G25		MacCleod+	6.7, 22	in prep		-
12	G358	ATCA	Breen+	mm	Published	(9)	ApJ
13	G358	ALMA-SMA	Brogan+	mm	Published	(10)	ApJL
14	G358	Hh	MacCleod+	New Methanol masers	Published	(11)	MNRAS
15	G358	LBA	Burns+	6.7	Published	(12)	Nat.Ast.
16	G358	Various VLBI	Burns+	6.7 movie	in prep		-
17	G358	Various VLBI	Burns+	Maps of rare masers	in prep		
18	G358	VLBA	Burns+	6.7 and 12.18	in prep		
19	G358	Asia-Pacific VLBI	Orosz+	7.6, 7.8	in prep.		ApJL
20	G358	VLA	Chen+	multiple lines methanol	Published	(13)	ApJL
21	G358	VLA	Chen+	New lines + Methanol	Published	(14)	Nat. Ast.
22	G358		MacCleod+	6.7 GHz monitoring	in prep		
23	G358		MacCleod+	6.2, 12.2, 20.3, 20.9	in prep		-
24	G358	VLA	Bayandina+	6.7, 12.2, 22.2	in prep		-
25	G358	SOFIA	Stecklum+	FIR	in review		A&A_L
26	G358	Sm and Hh	Volvach+	19.9, 20.9	Published	(15)	MNRASL
27	G358	ATCA	Breen+	Rare transitions	in prep		-
28	G24.33	EVN, VLBA	Olech+	6.7, 12.2, 22.2	in prep		-
29	G24.33	Tr	Olech+	OH, Meth	in prep		-
30	G24.33	Hh	v. d. Heever+		in prep		-
31	G24.33	ALMA	Hirota+	Thermal and maser	in prep		-

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[2] Volvach, L. N. *et al.* Flaring water masers associated with W49N. A&A **628**, A89 (2019).

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[5] Bayandina, O. S., Burns, R. A., Kurtz, S. E., Shakhvorostova, N. N. & Val'tts, I. E. JVLA overview of the bursting H$_2$O maser source G25.65+1.05. *arXiv e-prints* arXiv:1812.11353 (2018). 1812.11353.

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[13] Chen, X. *et al.* $^{13}CH_3OH$ Masers Associated With a Transient Phenomenon in a High-mass Young Stellar Object. ApJL **890**, L22 (2020).

[14] Chen, X. *et al.* New maser species tracing spiral-arm accretion flows in a high-mass young stellar object. *Nature Astronomy* (2020).

[15] Volvach, A. E. *et al.* Monitoring a methanol maser flare associated with the massive star-forming region G358.93-0.03. MNRAS **494**, L59–L63 (2020).

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

Reminders:

All G358 papers should include a member from the Ibaraki team in the author list and an acknowledgement of their funding.

All G24.33 papers should include a member from the Torun team in the author list and an acknowledgement of their funding.

All Orion-S6 papers should include a member from the Ibaraki team in the author list and an acknowledgement of their funding.

All NGC2071 papers should include a member from the VERA / Sunada team in the author list and an acknowledgement of their funding.

All G85 papers should include a member from the Ibaraki team in the author list and an acknowledgement of their funding.

All G359 papers should include a member from the Ibaraki team in the author list and an acknowledgement of their funding.

All G034.196-0.592 papers should include a member from the Ladeyschikov team in the author list and an acknowledgement of their funding.

3.3 Disk kinematics

We know (as reported in our previous publication) that the apparent maser motion is too fast to be physical gas motion, and instead is rather the propagation of maser-producing conditions as heat from accretion propagates thought the disk. The physical disk structure in which this occurs is likely to be (comparatively) slowly evolving. Imagine a submarine sonar wave probing the nearby waters without disturbing them. Based on this premise, each epoch can be thought of as a sample of the properties of the disk at ever increasing radii. Essentially, the spot maps from the full data set can be overlain to:

- Give a more fully sampled view of the structure and kinematics of the disk.
- Investigate the radial properties of the disk. One of which being kinematics; ΔV vs R.

3.3.1 Spiral structure

What is revealed is a structure that somewhat resembles a 3-armed (or more) spiral whose direction of in-spiralling matches that seen by Chen et al. Nature Astronomy.

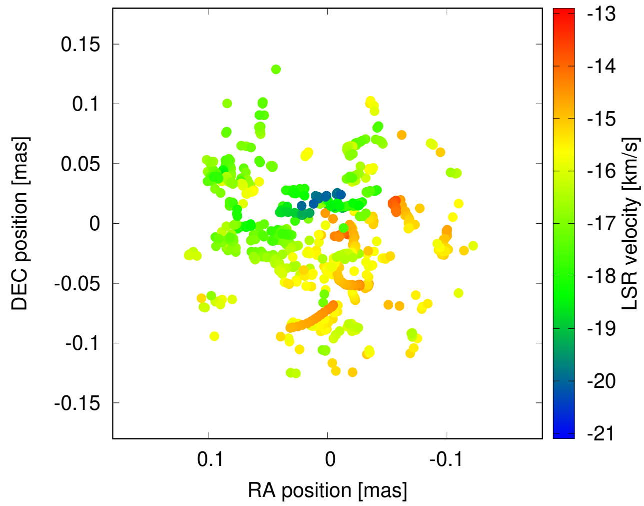

Figure 4: A combined view of all maser spotmaps in derived from VLBI monitoring

3.3.2 Disk kinematics

PV diagrams for all epochs were made by centering all maps on MM1, and drawing a PV slice through all epochs (slice shown in Figure 2). The results are shown in Figure 5. It can be seen that the steepness and range of velocities decreases over time (i.e. as the disk is sampled at ever larger radii). This is what would be expected for differential rotation, possibly Keplarian.

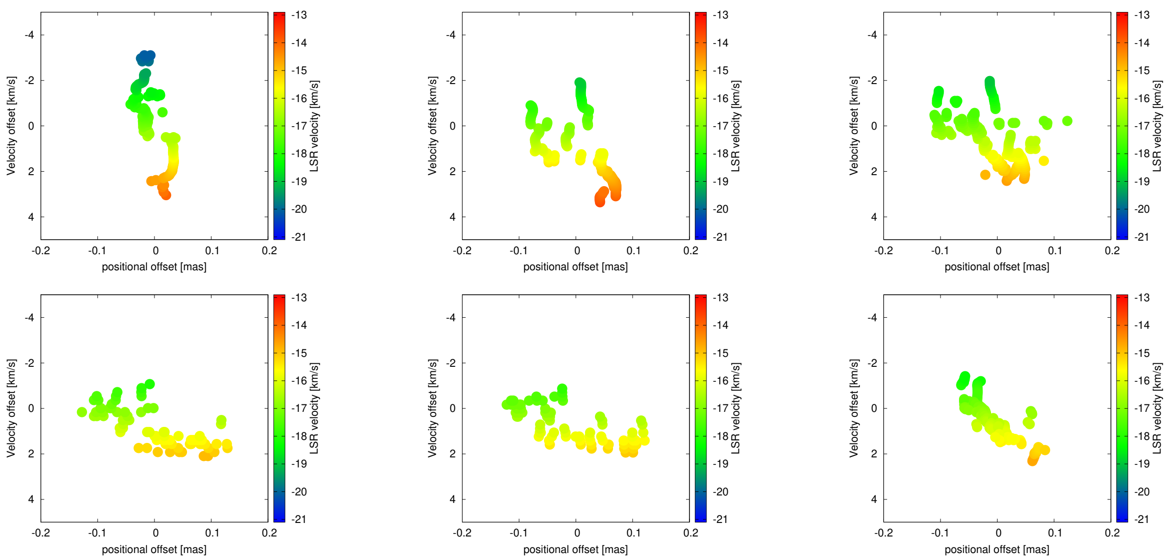

Figure 5: PV diagrams for all individual epochs (cuts shown in Figure 2)

Combining the spotmaps for all epochs and gridding the velocity information into 15 x 15 map bins produces a smoothed velocity map, shown in Figure 6. This was used to confirm the orientation of the PV slice.

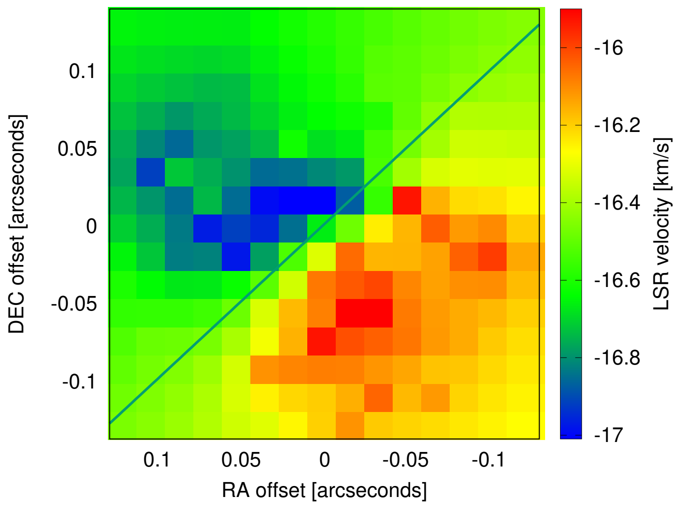

Figure 6: Gridded view of the combined velocity structure using all epochs

A PV diagram for the full disk was made by combining all spotmaps. The result is shown in Figure 7.

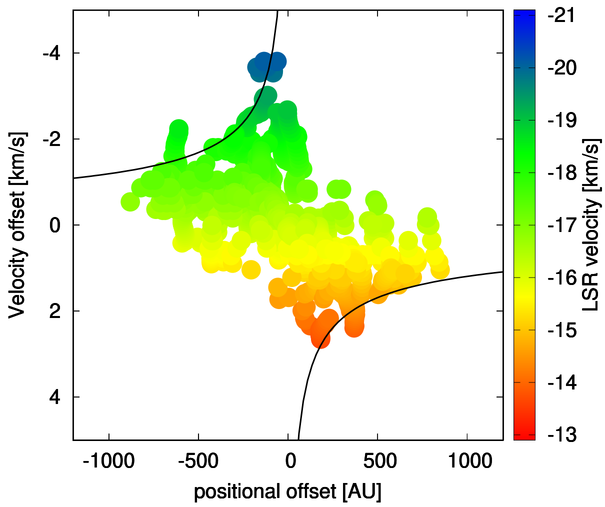

Figure 7: PV diagram for the full data set with a NNW-SSE cut

3.3.3 Enclosed mass

In this figure I have crudely fit a Keplarian envelope function to the data which corresponds to an enclosed mass of 1.6 Mo. This may seem low but it should be noted that the G358.93-0.03 MM1 system is likely quite face-on, as is suggested by the roundness of the maser rings, and the fact that spiral arms (Chen et al. 2020) are visible to the observer.

3.3.4 Infall

Yet another interesting result of this analysis is that there is clear evidence of infall, as can be seen in the width of the PV diagram. Infall seems present at all radii (from the 371 - 869 AU sampled by our VLBI observations). It should also be mentioned that the width of the PV diagram changes depending on the choice of PV cut orientation (Figures 7 and 8).

Here are my thoughts about problematic aspects of this analysis. Looking at the combined spotmap (Figure 4) and gridded velocity structure (Figure 6) one can imagine two possible scenarios:

- A Keplarian disk whose pole is orientated NNW-SSE.
- A disk whose pole is orientated N-S, which also has a strong infall signature.