Cosmic Masers: Proper Motion toward the Next-Generation Large Projects
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HMSFR G024.33+0.14: A possible new discovery in the making

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Abstract. Since 2017, and the formation of the maser monitoring organisation (M2O), we have observed several intriguing events. These events have included possible accretion bursts, strong jets, periodicity after a flare, a heat-wave of radiation travelling outward at a fraction of the speed of light, to name a few. In September 2019 the M2O was notified of another source showing flaring behavior, and here we present the possibility of the first discovery of long-term maser periodicity from the high-mass star formation region (HMSFR) G024.33+0.14, with a period of about 3000 days.

Keywords. masers, stars: formation, masers: flares, ISM: individual (G024.33+0.14)

1. Introduction

After the Maser Monitoring organization (M2O) was established, the international community of single-dish telescopes started working together more closely. Since then, and even some prior to the M2O, the community observed several very intriguing events, several possible accretion bursts from HMSFRs, e.g., the discovery of strong jets (Caratti o Garatti *et al.* 2017), periodicity after a flare (Proven-Adzri *et al.* 2019), and a heat-wave of radiation travelling radially outward Burns *et al.* (2020). This has also led to the discovery of roughly 30 new maser transitions, e.g., Brogan *et al.* (2019); MacLeod *et al.* (2019); Hunter *et al.* (2020), and the disentanglement of the sub-structures of the accretion disk around the protostar G358-MM1 Chen *et al.* (2020); Burns *et al.* (2023). In September 2019, the community was notified about another flaring event from the HMSFR, G024.33+0.14 (hereafter G024.33) Wolak *et al.* (2019), which has shown flaring previously in 2011. Archival data from Parkes (between 1992 and 1993) Caswell *et al.* (1995), seem to suggest evidence for long-term periodic variability with a period of ∼3000 days (∼8.2 years).

2. HMSF region G024.33: periodic maser source with the longest period

Figure 1 shows the time series of seven spectral features of the 6.7 GHz methanol maser source G024.33 (Torun and HartRAO). With an assumption of a 3000 day recurrence (the average time difference between the flux density peaks of seven velocity components shown in Figure 1), the Parkes data from 1992 to 1993 have been extrapolated to the

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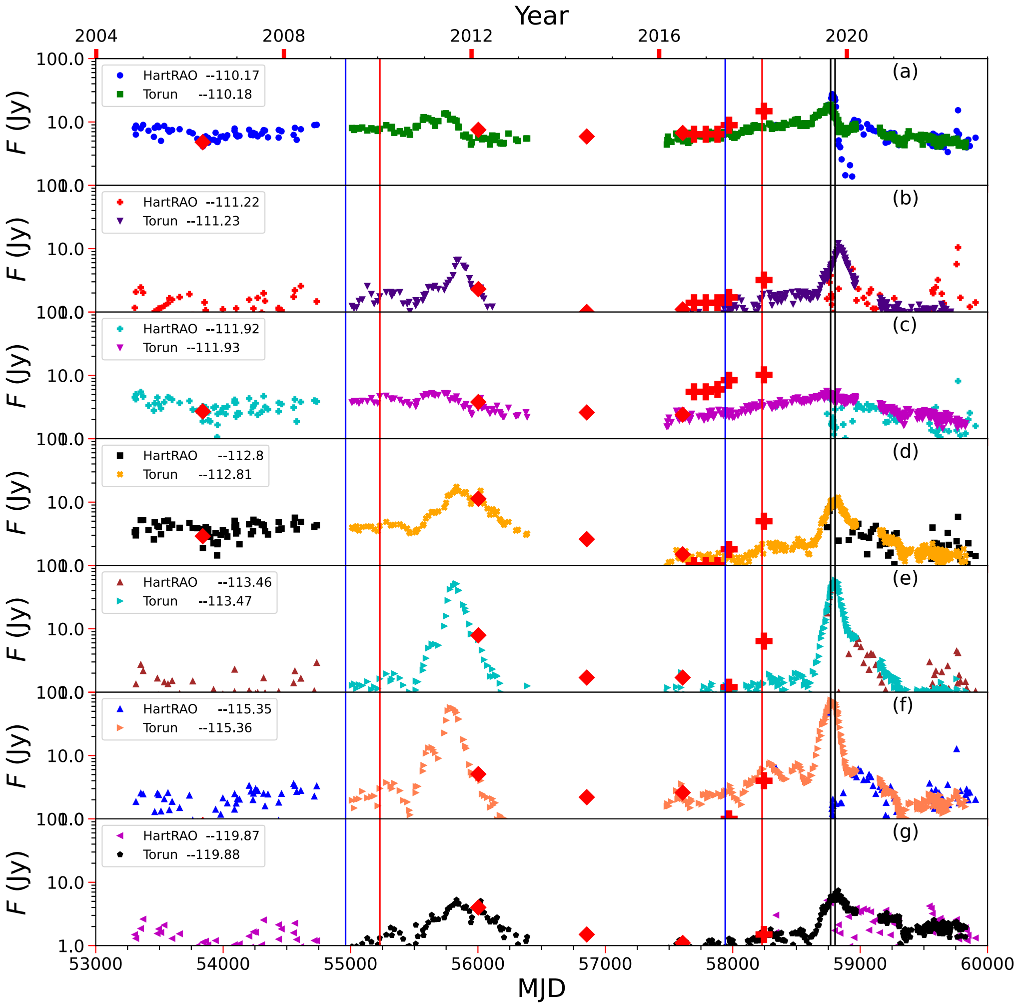

Figure 1. Time series of the flux density of the seven velocity features at; $V_{\rm LSR} = 110.16$ km s^{-1}, $V_{\rm LSR} = 111.22$ km s^{-1}, $V_{\rm LSR} = 111.92$ km s^{-1}, $V_{\rm LSR} = 112.80$ km s^{-1}, $V_{\rm LSR} = 113.46$ km s^{-1}, $V_{\rm LSR} = 115.35$ km s^{-1}, and $V_{\rm LSR} = 119.88$ km s^{-1}. The red pluses show the Parkes data extrapolated to the most recent flare, and the vertical blue and red lines demarcate the last two epochs from Parkes, extrapolated to 2009-10 and 2017-18. The vertical black lines show the peak flux density of panel (e) and (f).

most recent flare that was observed in 2019 (plotted with the red pluses). In addition, the last two epochs from Parkes (Dec 1992 and Sep 1993) are also demarcated with vertical blue and red lines for both of the flares observed 2010 and 2019, and the red diamonds demarcate various observations from 2003 onward. The similarities in the behavior of the flux density between the Parkes and the Torun data can be seen most prominently in panels (e) and (f), where increases in the flux density seem to correspond remarkably well. Although, the increase in flux density seen in these panels are not identical prior to the peak flux densities in 2010 and 2019, it can still be suggested that G024.33 is possibly the longest periodically flaring 6.7 GHz methanol maser. Therefore we predict that the next flare will happen in 2027, and the first activity prior to the flares will start in 2025, with the inferred 3000-day recurrence.

References

Caratti o Garatti, A., *et al.* 2017, *Nature Physics*, 13, 3
Brogan, C. L., *et al.* 2019, *ApjL*, 881, 2
Proven-Adzri, E., *et al.* 2019, *MNRAS*, 487, 2, 2407
Burns, R., *et al.* 2020, *Nature Astronomy*, 4, 506
MacLeod, G.C., *et al.* 2019, *MNRAS*, 489, 3, 3981
Hunter, T., *et al.* 2020, *SAN*, 29, 2
Chen, Xi., *et al.* 2020, *Nature Astronomy*, 4, 1170
Burns, R., *et al.* 2023, *Nature Astronomy*, 7, 557B
Wolak, P., *et al.* 2019, *The Astronomer's Telegram*, #13080
Caswell, J., *et al.* 1995, *PASJ*, 12, 37

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