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A Masing Event in the Cat's Paw

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Abstract. We present Kitty, an unprecedented and near simultaneous flaring event in ten transitions (6 hydroxyl, 1 water and 3 methanol), that began on 1 January 2015 in the massive star-forming region NGC6334F located in the Cat's Paw Nebula. The brightest components in each transition increased by factors of 20 to 70 in line with a factor of ∼70 increase in dust emission luminosity for the source MM1. We also report the detection of only the fifth known 4.660 GHz hydroxyl maser and that it varied in a correlated fashion with 1.720, 6.031, and 6.035 GHz hydroxyl counterparts. We postulate that if Kitty, and two historical flares in 1965 & 1999, are accretion events and are caused by the successive passages of a secondary star disrupting the accretion disk, where the frequency of occurrence is cycling down at a rate of ∼2.2, it is possible another event will occur in 2022.

Keywords. masers, stars:formation, radio lines:molecular:interstellar.

1. Introduction

NGC6334F is a well-studied massive star-formation region with many associated species of masers (Cohen *et al.* 1995 and references therein). Weaver *et al.* (1968) first reported a flare of the 1665 and 1667 MHz hydroxyl masers of NGC6334 occurred in 1965. Variability studies of the 6.7 and 12.2 GHz methanol masers have been presented by MacLeod *et al.* (1993) and Goedhart *et al.* (1994); the former reported significant variation in a single 12.2 GHz maser feature while the latter reports a single, but different, feature also underwent a large increase during their monitoring period. We report a significant flaring event in ten maser transitions, including 6 of OH, 1 of H_2O, and 3 of CH_3OH, associated with NGC6334F and identify a third flare event in 1999 through re-analysis of Goedhart *et al.* (1994) data.

2. Results & Prediction

We were alerted to an unprecedented flaring event in NGC6334F when we discovered new 6.031 & 6.035 GHz excited-OH maser features. We determined the magnetic field strength and orientation, both were B ∼ +1.4 and +1.9 mG for 6.031 and 6.035 GHz respectively, which were not the same as previously reported (Caswell *et al.* 2011). This source was included in the maser monitoring programme at Hartebeesthoek Radio Astronomy (HartRAO) as a calibrator. In Fig. 1 we present the dynamic spectrum of the 6.7 GHz methanol masers associated with NGC6334F. A flaring event is clearly visible; it began on 1 January 2015 and peaked on 15 August 2015, at least in several features. The source is presently undergoing a secondary flare. Analysis of the associated 1.665

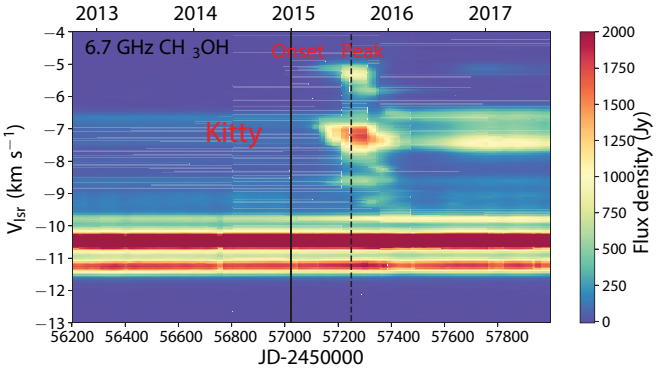

Figure 1. Dynamic spectrum of the 6.7 GHz methanol masers associated with NGC6334F.

GHz Hydroxyl, 12.2 GHz methanol, and 22.2 GHz water maser transitions showed correlated flaring. We refer to all features associated with this flare in all transitions as Kitty because NGC6334F is located in the Cat's Paw Nebula. Kitty also had flaring features in 1.720 & 4.660 GHz hydroxyl and 23.1 GHz methanol transitions. The 4.660 GHz OH maser is only the fifth discovered and varied in a correlated fashion with the other hydroxyl maser features in particular the 1.720 GHz maser; contrary to theory in Cragg *et al.* (2002) and Gray *et al.* (1992) where 4.765 GHz OH masers are predicted.

Previously detected features in NGC6334F (Ellingsen *et al.* 1996) did not change in a correlated way to features of Kitty and polarisation results suggested Kitty resides in a distinctly different region. Very long baseline interferometry (unpublished) and Very Large Array observations (Hunter *et al.* these proceedings) confirm this for the 6.7 GHz masers; Kitty is associated with MM1 where the total luminosity traced by the dust emission increased by a factor of ∼70 (Hunter *et al.* 2017).

Finally, re-analysis of historical data has been used to identify two other flares associated with NGC6334F. We postulate that if these are accretion events and are caused by successive periastron passages of a secondary star disrupting the accretion disk (e.g. Bally 2002) occurring in 1965, 1999, & 2015, then the frequency of occurrence is cycling down at a rate of ∼2.2 per event, and it is possible that another event will occur in 2022.

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