The Flaring Activity of Sagittarius A*

At 3 mm observed with ATCA

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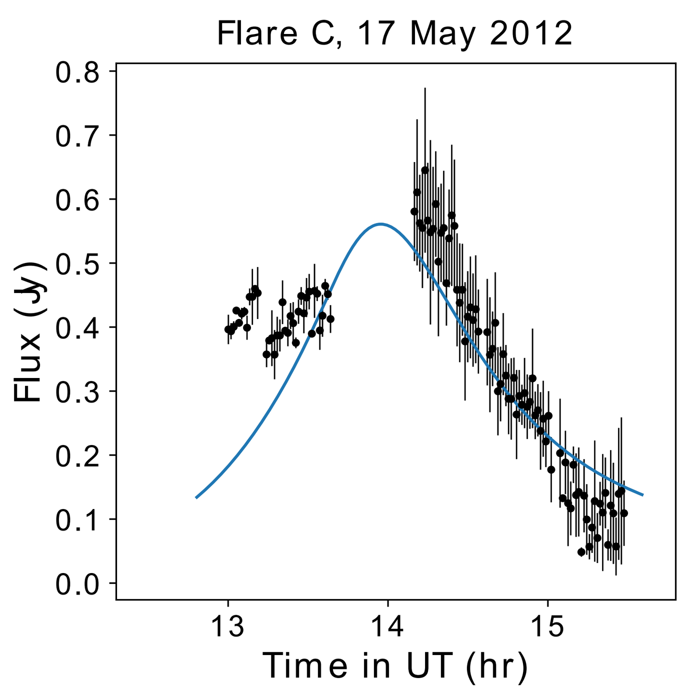
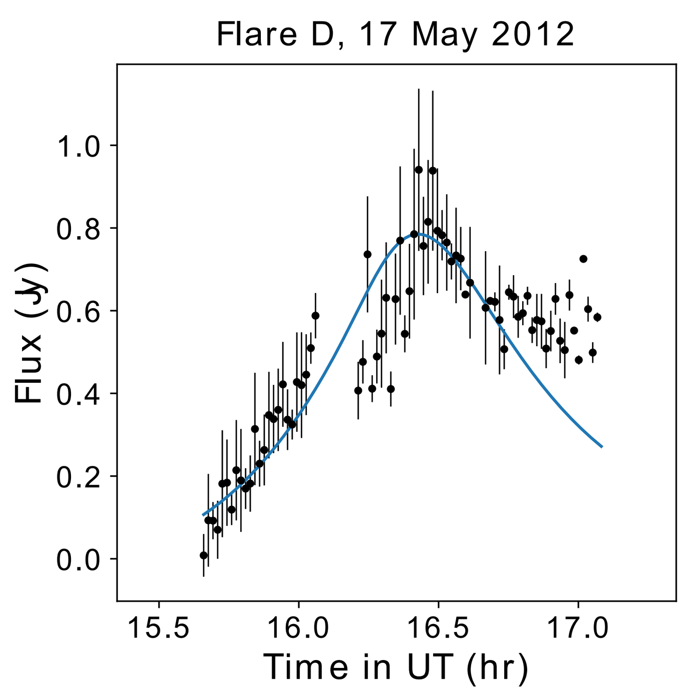
Introduction

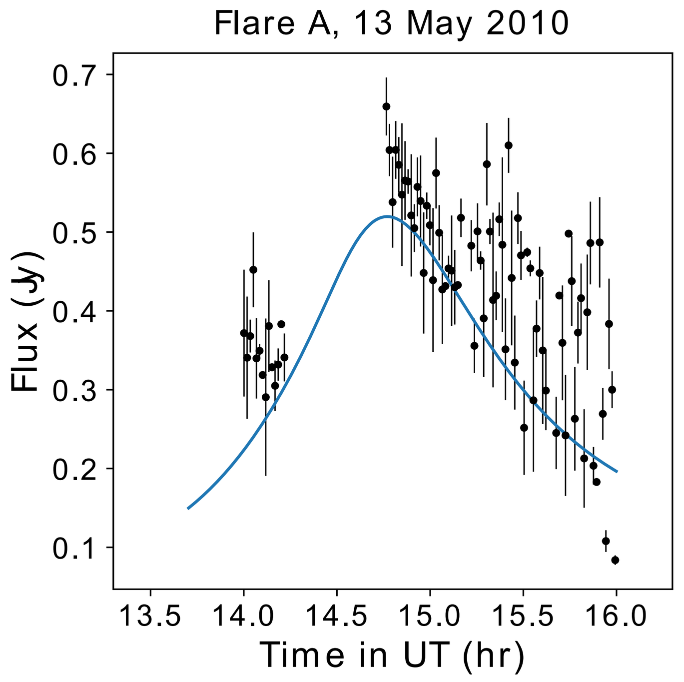
Milky Way's central supermassive black hole Sagittarius A* is extremely underluminous with bolometric luminosity eight orders of magnitude lower than its Eddington luminosity, and exhibits properties similar to low luminosity active galactic nuclei. Sagittarius A* undergoes regular flaring activity arising from the innermost region of the accretion flow. This strong flux variability has been observed from NIR & X-ray to radio and submillimeter. Multiwavelength observations have shown that the NIR & X-ray flares occur simultaneously, and are followed by the submm & radio flares. The study of the flux variability provides indirect constraints on the details of the emission mechanism and allows us to investigate the accretion around a low-luminosity AGN.

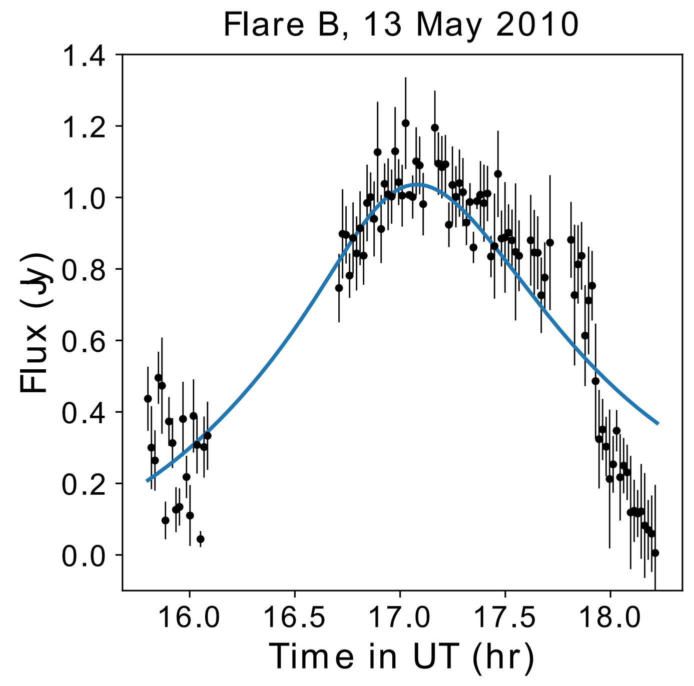
To study these flares, we observed the Galactic Center at 3 mm using ATCA between 2010 & 2014 for 23 days in total. Here we present the results of our observations and analysis.





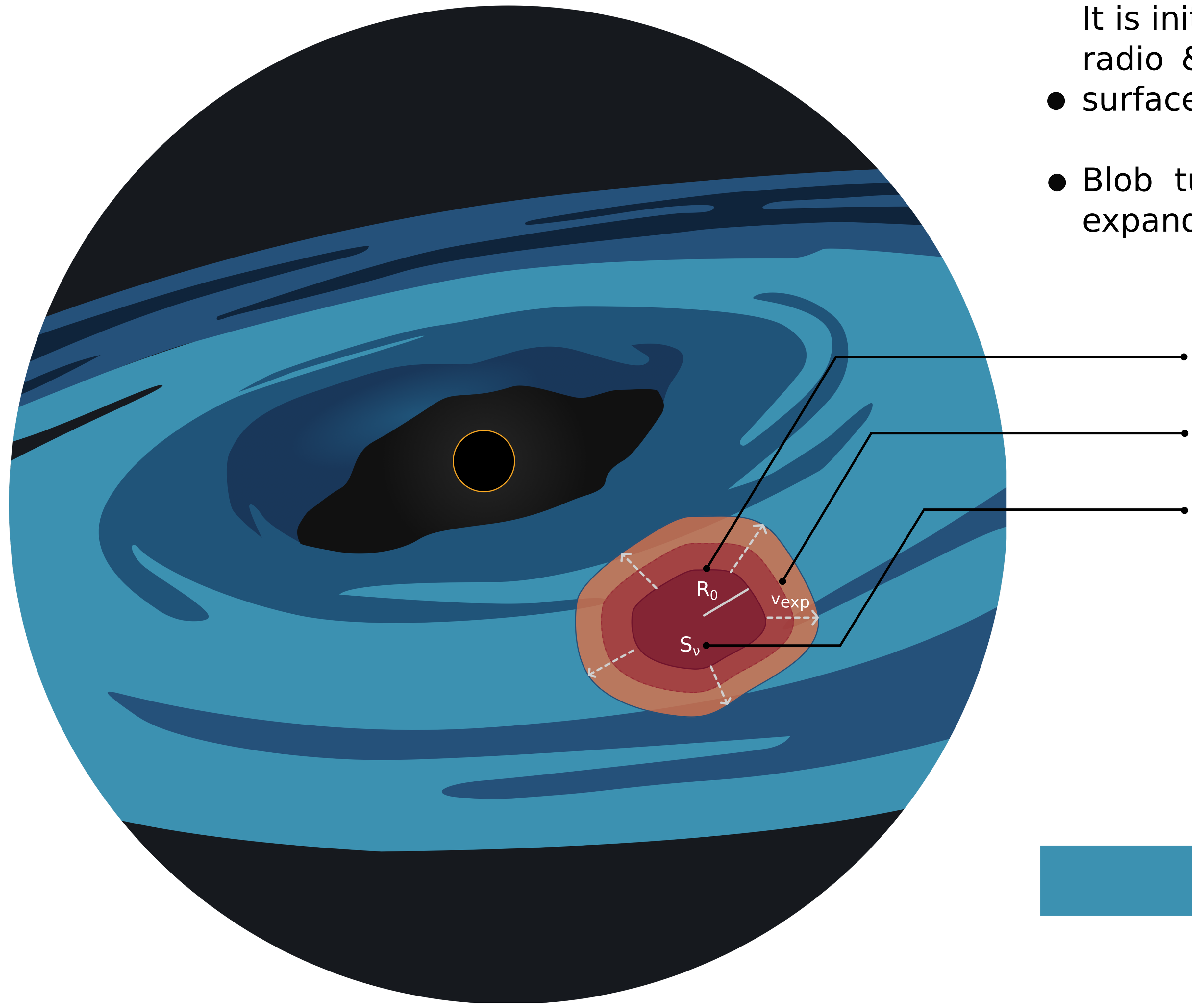
The plots show all the detected flare events detected in our observations (black points) and the fitted model curve using the adiabatically expanding plasmon model (blue curves).

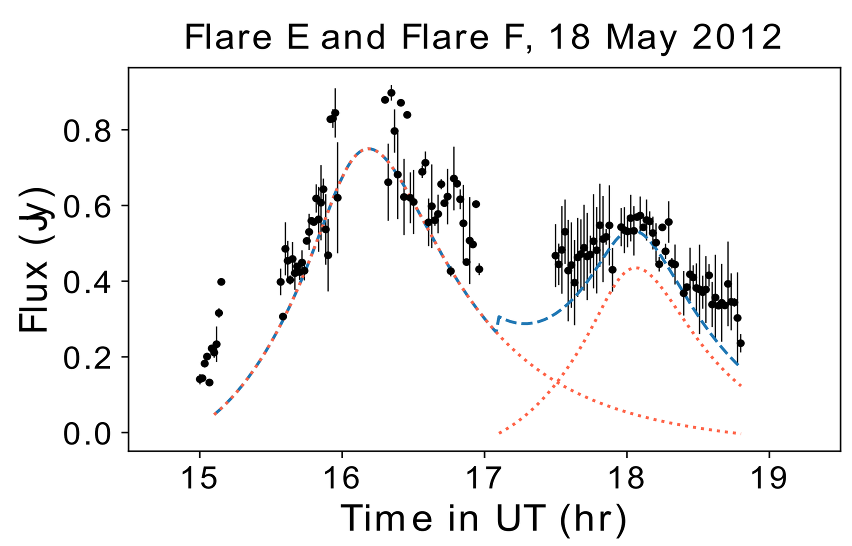




Results

- We detected 6 flaring events from our 86 GHz observations. The flares last typically for 1.5 - 3 hours.
- The adiabatically expanding plasmon model was successfully used to describe the flaring process and obtain source parameters.
- The sources are 1-3 Schwarzschild radii in size, expanding at 15 - 35 × 10^{-3} c, and the turnover frequency occurs in the submillimeter.
- The source arises as hotspot in accretion disk in a Keplerian orbit, or it gets caught up in the nozzle of the jet and expands as it moves along the jet.
- We do not detect any enhanced activity during the flyby of the source G2/DSO.





Questions? Come say Hi!
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Flare Modelling and Analysis

- Structure function analysis & Bayesian blocks analysis were used to identify the flare events from quiescent behaviour.
- We use the adiabatically expanding plasmon model, developed by Van der Laan (1966), to analyze the flares & deduce source properties.
- The model assumes a source of synchrotron emitting relativistc electrons that leads to the flares.
- It is initially optically thin in IR & X-ray but initially optically thick in radio & submm. The initial rise in flux is caused by increase in surface area.
- Blob turns optically thin at successive lower frequencies as it expands.

Initial size $\mathbf{R_0}$ determines the peak.

Expansion speed $\mathbf{v_{exp}}$ determines flare time period.

Peak flux $\mathbf{S_{max}}$ at each frequency occurs when the source turns from optically thick to optically thin.

Turnover frequency $\boldsymbol{\nu_{max}}$ is the frequency at which at the initiation the source changes from optically thick to thin.

Initial optical depth depends only on particle spectral index **p**.

Flare Parameters

Flare	v_{exp} ×10^{-3} (*c*)	S_{max} (*Jy*)	ν_{max} (*GHz*)	R_0 (R_s)	α_{sync} = *(p-1)/2*
A	15 ± 0.2	3.57 ± 0.21	469.2 ± 70	1.67 ± 0.06	0.60 ± 0.15
B	21 ± 0.1	6.95 ± 0.29	378.7 ±102	3.61 ± 0.03	0.77 ± 0.20
C	13.5 ± 0.2	5.19 ± 0.37	542.7 ± 67	1.60 ± 0.05	0.66 ± 0.21
D	22 ± 0.3	7.45 ± 0.27	512.3 ± 57	1.67 ± 0.03	0.67 ± 0.30
E	23 ± 0.4	7.73 ± 0.40	545.9 ± 72	2.27 ± 0.01	0.55 ± 0.32
F	17 ± 0.3	6.25 ± 0.33	652.0 ± 81	1.35 ± 0.02	0.67 ± 0.23

References

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