Modality Analysis in The Radio Light Curves of Intra-Hour Quasars: PKS 1257-326 and J1819+3845

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Background

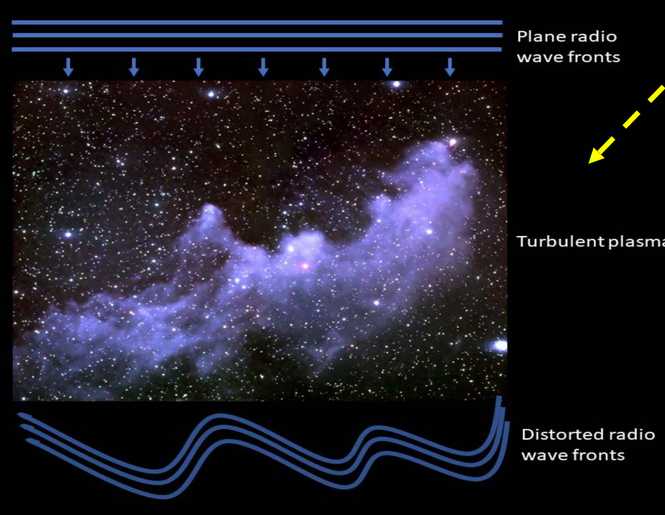
- Statistical techniques have been widely used in the analysis of astronomical data sets to detect clustering in certain characteristic quantities. Studying the distribution of data can provide a crucial starting point for understanding the system as well as the underlying mechanism.
- We investigate the modality of flux density distributions of two intra-hour variable radio quasars, PKS1257-326 and J1819+3845, whose variations are due to interstellar scintillation occur along the line of sight between observer and source.
- The purpose of this work is to investigate the physical origin of changes in the modality of flux density distribution and to establish whether there is a relationship with either intrinsic or extrinsic effects.
- The comparison of intra-day variability (IDV) and intra-hour variability (IHV) radio sources with different timescales and fractional changes in flux density will also improve our understanding of the underlying process.

Data

- Total flux density monitoring with the Australia Telescope Compact Array (ATCA) at frequency of 4.8 GHz between 2001 and 2006.
- Further details for the statistical techniques to study changes in the flux density distribution and quantify the modality of the distribution are described in Said, N. M. M., Ellingsen, S. P., Liu, J., et al. 2021a, Monthly Notices of the RAS, 506, 288.

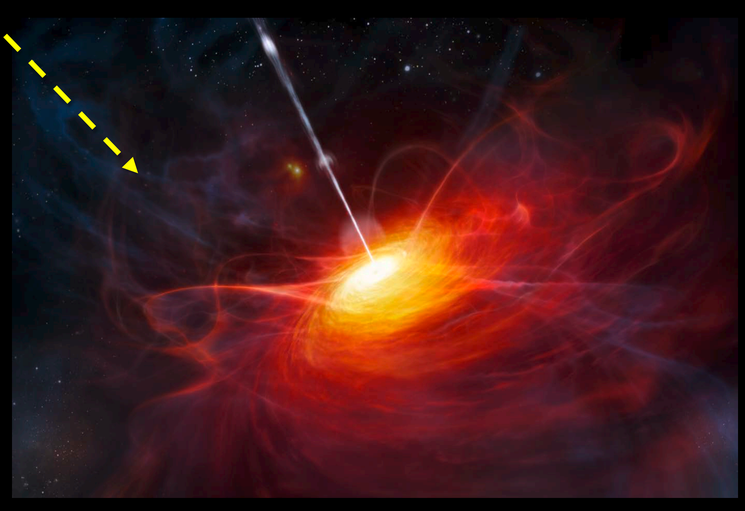
Results and Discussion

Interstellar scintillation (extrinsic)

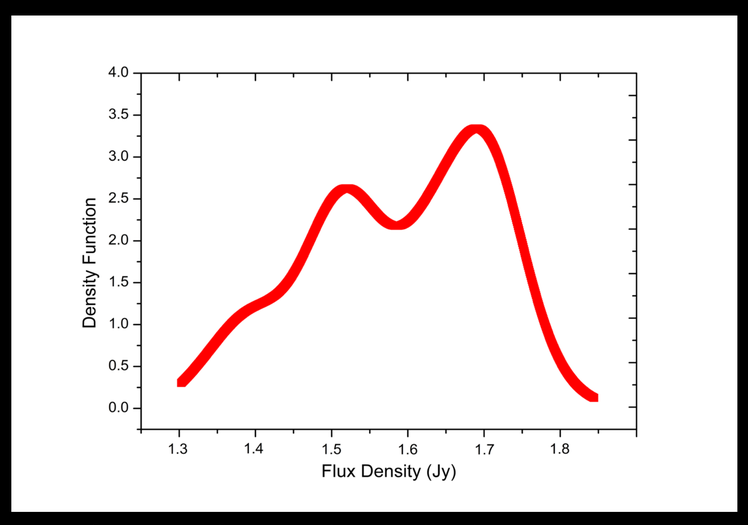


Interstellar scintillation (ISS) is the interference phenomenon seen in radio waves, caused by an inhomogeneous ionized medium between the source and observer.

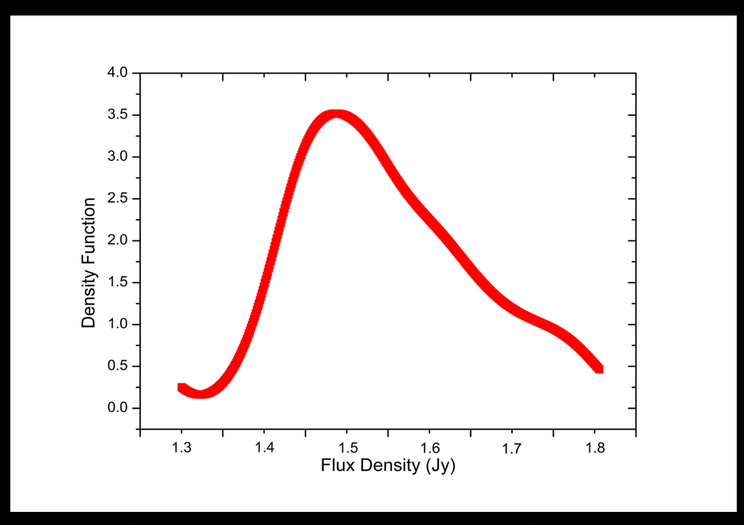
Quasi-periodic flarings (intrinsic)



One potential origin for the flares is Quasi-Periodic Oscillations (QPOs). QPOs are associated with varying accretion rates between the central black hole and the inner edge of the accretion disk.



Presence of bimodal flux density distributions is likely due to the extrinsic effect of interstellar scintillation.



Presence of unimodal flux density distributions is likely associated with the compactness of the scintillating component (during the flare) and the source intrinsic evolution.

Image credit: Gary Stevens, M.Kornmesser, ESA, NASA & Hubble

Conclusion

- The statistical analysis performed using the Pearson's S-K difference test shows that the flux density distributions of these sources are bimodal and non-normal.
- The comparison of these intra-hour variable radio sources to our previous statistical analysis of intra-day variable BL Lac object PKS B1144-379 supports our hypothesis that physical changes in radio light-curve modality correlate with intrinsic evolution of the blazar.
- These findings also demonstrate that our approach provides a robust technique for improving our understanding of the underlying process and would help in the modelling of flux density distribution.

References

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