Astrophysical Phenomena Revealed by Space VLBI
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The Pearson-Readhead Survey From Space

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Abstract

We are using the VSOP mission to observe a complete sample of Pearson-Readhead survey sources at 4.8 GHz to determine core brightness temperatures and pc-scale jet properties. To date we have imaged 27 of the 31 objects in our sample. Preliminary results show that the majority of objects contain strong core components that remain unresolved on baselines of ~30,000 km. The brightness temperatures of several cores significantly exceed 10^{12} K, which is indicative of highly relativistically beamed emission.

1 Introduction

Ground-based VLBI imaging surveys have been of critical importance in determining the general morphological and dynamical properties of the nuclear regions of active galaxies. Studies of individual sources alone leave many questions unanswered, and can even provide a biased view of nuclear activity. The statistical results obtained from imaging surveys have been key in providing constraints and insights for theoretical models of nuclear jets and environments. The same can be true for space-based VLBI imaging surveys.

The VSOP imaging survey we are undertaking is aimed at studying the nuclear regions of a complete sample of active galaxies. In addition to exploring the menagerie of source morphologies and dynamics, we will address a number of issues aimed ultimately at elucidating the fundamental characteristics of galactic nuclear activity and the physical conditions in these regions. These include the brightness temperature (T_b) distribution of the nuclei and the inner jet components, jet Doppler factors, and curvature.

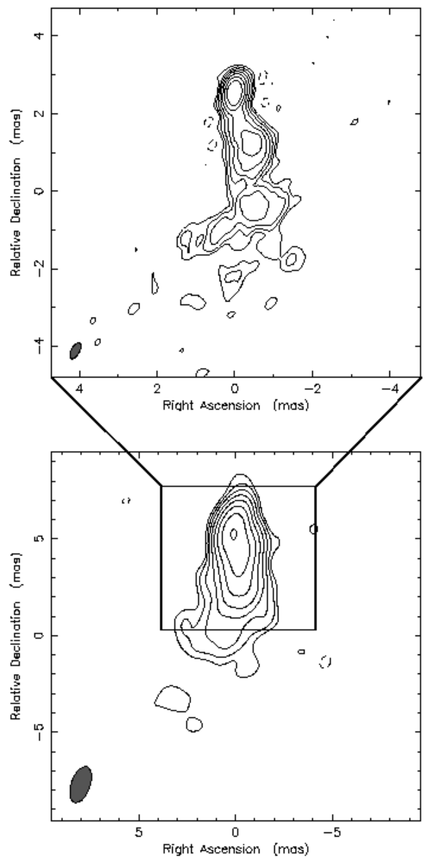

Figure 1: Images of 2200+420 (BL Lac) at 5 GHz as seen with VSOP (top panel), and with space-baselines removed (bottom).

2 The Sample

The complete sample from which we have drawn our sources is the Pearson-Readhead sample, which is defined by the following criteria: (1) $\delta > 35°$; (2) $|b| > 10°$; and total flux density at 5 GHz > 1.3 Jy (Pearson & Readhead 1988). This sample is ideal for a VSOP survey because the sources are strong, the VSOP (u, v) coverages are especially good above $+35°$ declination, and multi-epoch ground-based VLBI data and other existing supporting data on these sources exceeds that of any other possible sample. Based on the multi-epoch ground-based VLBI observations at 5 GHz of this sample involving two of us (TJP and

ACSR), we have been able to carefully choose a complete subset of this sample having compact emission that is most likely to show fringes on VSOP baselines.

3 Results

To date we have imaged 27 of the 31 sources in the sample. In Fig. 1 we show a 5 GHz of 2200+42 (BL Lac). In the bottom panel, we also show the image of the source that can be made with the same data set if the baselines to the HALCA spacecraft are removed, and only the VLBA data are used. The box superimposed on the ground-only image shows the area of the map that is shown in the VSOP image. Note the significant increase in fine-scale detail that is apparent in the VSOP image compared to the ground VLBI image.

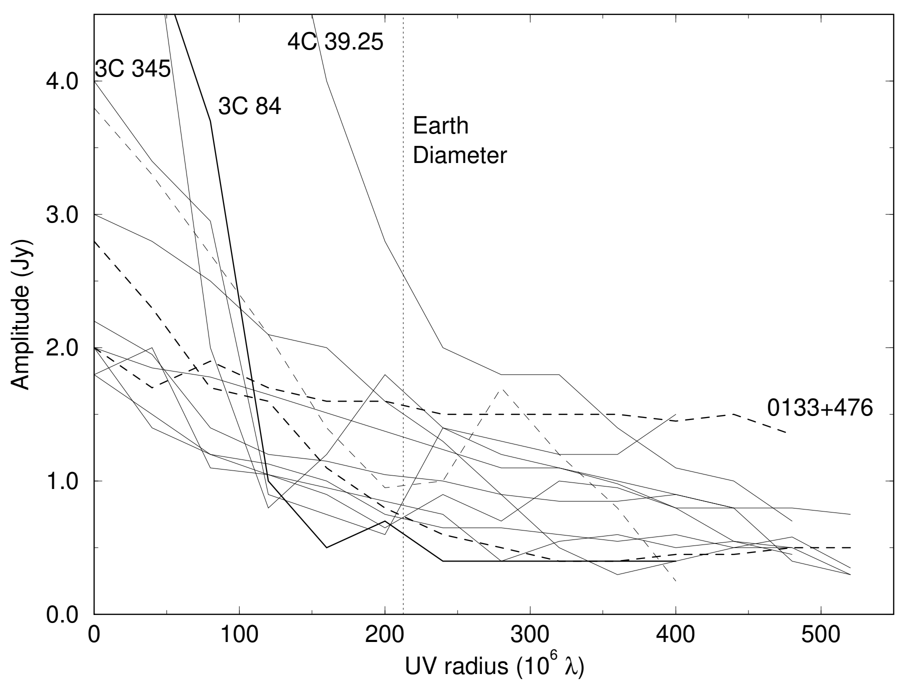

Figure 2: Upper envelope of visibility amplitude distribution plotted against (u, v) distance for strong sources in our Pearson-Readhead sample.

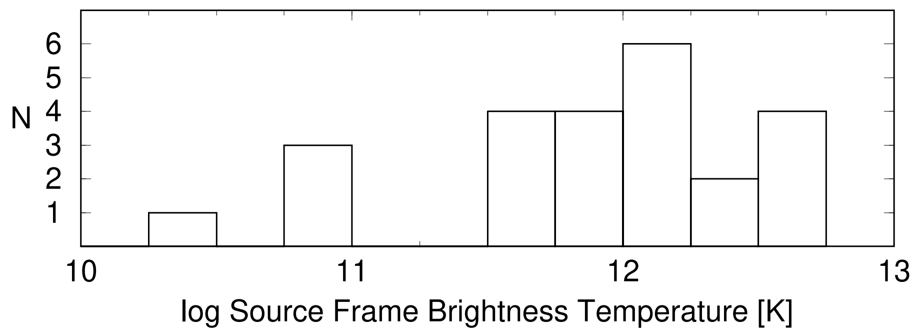

Figure 3: Distribution of source-frame core brightness temperature for fitted Gaussian components in our Pearson-Readhead sample. Most of these values may represent lower limits.

The fine-scale structure of nearly all of our sources is dominated by a bright, unresolved core component, as is revealed in plots of visibility amplitude versus (u, v) distance (Fig. 2). The curves show a pronounced flattening at baselines greater than an earth diameter, instead of dropping smoothly to zero. The brightness temperatures of many of these core components exceed 10^{12} K in the source rest frame (Fig. 3). For T_b's this high, the simplest way to alleviate problems associated with an inverse-Compton catastrophe (e.g., Kellermann & Pauliny-Toth 1969) is to assume that the emission is highly relativistically beamed. A preliminary analysis has shown that our brightness temperatures are positively correlated with 15 GHz variability amplitude, 5 GHz core-to-extended flux ratio, and fractional optical polarization, which are all known beaming indicators.

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References

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