VSOP AO2 PROPOSAL COVER SHEETS

DEADLINE : 8 May, 1998
SEND TO : VSOG, ISAS, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, JAPAN

Please read Appendix C of Announcement of Opportunity for details on how to fill in this Cover Sheet.

(1) Date prepared : April 26, 1998

(2) Proposal title : **Understanding the AGN Phenomenon. Radio continuum monitoring of the two variable BL-Lacs 0235+164 and 1749+096**

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(5) Proposal Abstract :

We propose a VSOP+ground array multiepoch study of the radio continuum flux density at 6 cm of the two BL-Lac radio sources **0235+164** and **1749+096**. Both sources are characterised by emission at X- and γ- ray energies and they are both undergoing a period of strong variability in the radio band. The present observations will allow us to study the bursts of radio emission on the VLBI scale, to locate the region of the variability and the detection of proper motion, to derive the intrinsic parameters of the flow, such as the Lorentz factor, and compare them with the expectations from the current models of variability at high energies and radio frequencies in AGN.

(6) Proposal Category (indicate all that apply):

Object type:

☑ AGN, ☐ Maser, ☐ Stellar, ☐ Pulsar, ☐ Other :

Observation type:

☑ Continuum, ☐ Spectral Line, ☐ Polarization, ☐ Time-critical, ☐ Other :

(7) Number of proposed experiments

An 'experiment' is one or more observations of one source at a fixed HALCA set-up. A request to observe the same source at 1.6 GHz and separately at 5 GHz requires two columns to be filled in in item (8) below. A request to observe the same source with HALCA simultaneously observing at 1.6 GHz and 5 GHz requires one column to be filled in. Multi-epoch observations of the same source at the same frequency – a 'monitoring experiment' – requires only one column to be filled in. Suggested observing dates, especially for for time-critical and monitoring experiments, should be specified in item (10).

The number of experiments in this proposal is: 2

(8) Details of proposed experiments

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Source name (J*hhmm*±*ddmm*)	0235+164	1749+096		
Alternative name				
RA(J2000) (hh mm ss.ssss)	02 38 38.922	17 51 32.825		
Dec(J2000) (dd mm ss.ssss)	16 36 59.19	09 39 00.60		
Observing frequency band (GHz)	5	5		
Continuum observations: Standard VSOP freq. channels? Channel A range (MHz) Channel B range (MHz)	 ☑	 ☑	 ☐	 ☐
Spectral line observations: Ch.A spectral line rest freq. (MHz) Ch.A LSR velocity (km/s) Ch.B spectral line rest freq. (MHz) Ch.B LSR velocity (km/s) FWHM of field of view required (mas)				
Min. spectral channels per IF channel				
Correlator averaging time (sec)				
No. of correlating passes (if >1)				
Total flux density (Jy)	4	3.5		
Correlated flux (mJy)	3	2		
Ground Radio Telescopes: Suggested array given at Item (10)?	 ☑	 ☑	 ☐	 ☐
GRT observing mode: 128Mbps LCP (standard) 128Mbps LCP/RCP 256Mbps LCP/RCP	 ☑ ☐ ☐	 ☑ ☐ ☐	 ☐ ☐ ☐	 ☐ ☐ ☐
Preferred correlator: No preference Mitaka Penticton Socorro	 ☐ ☐ ☐ ☑	 ☐ ☐ ☐ ☑	 ☐ ☐ ☐ ☐	 ☐ ☐ ☐ ☐
Monitoring programs: Number of observations Mean interval (days)	 3 270	 3 270		
Related AO1 proposal code(s)				

(9) VSOP spacecraft observing mode (see Section 3 and Table 5 of the VSOP Proposer's Guide):

☑ 2 channel x 16 MHz, 2-bit (Standard mode),

☐ Other:

Phase calibration tones:

☑ On (Standard continuum mode),

☐ Off (Standard spectral line mode)

(Include justification of any non-standard choice at (10) below)

(10) Additional notes to the scheduler :

0235+164 Suggested array: EF MC NT VLBA VSOP
Minimum Array: EF + VLBA (without MK) + VSOP
Suggested period of first observation: from 1Jul1999 to 15Sep1999
1749+096 Suggested array: EF MC NT VLBA VSOP
Minimum array: EF + VLBA (without MK) +VSOP
Suggested period of first observation: from 15Apr1999 to 1Jun1999

(11) Attach a scientific and technical justification, not in excess of 2 pages of text and 2 pages of figures. Up to one page of (u,v) plots per source may optionally be included.
(Refer to the VSOP Announcement of Opportunity for detailed instructions.)
Preprints and reprints will not be forwarded to the Scientific Review Committee.

Send two paper copies of the complete proposal to:

VSOP Observing Proposals
VSOP Science Operations Group
Institute of Space and Astronautical Science
3-1-1 Yoshinodai, Sagamihara
Kanagawa 229-8510 JAPAN

In addition, e-mail the completed LaTeX file to submit@vsop.isas.ac.jp

Information from the Cover Sheets of scheduled proposals will be made available from the VSOP WWW site.

Proposals must be received at ISAS by 8 May 1998

1 Scientific Background

The correlation between high energy emission bursts (optical, X-ray and γ-ray) and the flux variability at radio frequencies (from few hundreds to few GHz) in very active galactic nuclei is a well established phenomenon, however its details and implications are not totally disentagled. At present there are two main models which try to explain the correlation observed.

If we consider a jet flow accelerating as its internal energy is converted into bulk flow energy (Maraschi, Ghisellin & Celotti 1992, Marscher 1993), then the synchrotron emission at UV, optical and IR frequencies is confined to the region closest to the central engine, opaque to the radio emission. The radio emission is then produced outside this region, with the maximum intensity occurring where the Lorentz factor is highest. Self-Compton scattered γ- and X-ray would therefore be produced in coincidence with the synchrotron emission at high and low energies. Moreover Inverse Compton reflection of optical and UV photons produced by the accretion disk would take place in the vicinity of the central engine, producing again X- and γ-ray emission. In a model consisting of a decelerating flow of relativistic positrons and electrons (Melia and Konigl 1989, Marscher 1993) the UV photons produced by the accreation disk are upscattered to X- and γ ray energies. Radio and infrared synchrotron emission (plus self-Compton scattered X- and γ-ray emission) is produced where the Lorents factor decreases down to a value of ~ 10.

The behaviour of the energy bursts detected, i.e. how they begin, evolve and propagate to low frequencies, is very important to discriminate between the proposed models. The timescale of the flux density variations is strictly related to the size of the emitting region, thus observations of correlated variability and time delays should reveal the relative location of non-thermal emission at the various frequencies. For these reasons, the Italian astronomical community has been carrying out a multifrequency study on a sample of blazars. Our study involves X-ray observations with the SAX satellite, optical observations with national telescopes, and radio frequency single dish monitoring at 5 GHz and 8.4 GHz with the Italian VLBI antennas located in Medicina and Noto. The multifrequency campaign carried out for 3C279 (Maraschi et al. 1992) turned out to be extremely successful in the study of the nature on the source outbursts and their interpretation. It is clear that a much larger number of sources for which this kind of study is carried out is envisaged, in order to draw more general conclusions.

2 The present proposal

Continuum monitoring at parsec-scale resolution of high energy emitting radio sources is very important for a variety of reasons. It allows the location of the radio flux density variations, secondly the determination of the brightness temperature of the VLBI knots and the study of their proper motion is essential to derive constraints on the Lorentz factors, a critical parameter in the two theories briefly summarised above.

¿From the sample of blazars monitored by us with single dish observations at 8.4 GHz and 5 GHz (Venturi, 1997) we have selected 2 sources which have turned out to be strongly variable during the timescale of our monitoring (20 months thus far) and which therefore are the most promising for the detection of morphological changes and proper motion on the very high linear scale provided by Space VLBI at 5 GHz. The sources we selected are 0235+165 and 1749+096. They are both BL-Lac type objects, at a distance respectively of z=0.9 and z=0.36. A plot of their total flux variations at 8.4 GHz from January 1996 to April 1998 is given in Fig. 1.

0235+164 is presently undergoing a major burst. Its total flux density at 5 GHz has increased from 0.4 Jy at the beginning of 1997, to almost 4 Jy in April 1998.

1749+096 showed a major burst from mid-1996 to the end of 1997, going from 0.9 to 4 Jy, and the total flux density seems to have reached a plateau of $\sim$3.5 Jy at the moment. The analysis of the structure function for 1749+096 indicates that shorter time scale variations are superimposed to the long term variation.

With the present proposal we ask to carry out a multiepoch continuum of these two variable sources with Space VLBI at 5 GHz. The requested observations will allow us to follow the evolutions of the flux density

bursts on the sub-parsec scale, to detect proper motion, if present in the source, or to place stringent limits on it, and it will allow us to derive the intrinsic parameters of the flow, in particular the Lorentz factor, essential to test the models of the energy emission phenomenon in very active galactic nuclei. The linear resolution of the proposed observations is lower than 1 pc for both sources, very close to the region where the inverse Compton scattering mechanism takes place, according to the model proposed by Maraschi et al. 1992.
Both sources are SAX high priority targets in the next two years (project leader of the SAX observations is P. Padovani). Furthermore the total flux single dish monitoring carried out in Medicina and Noto will continue thoroughout the duration of the SAX and VSOP mission on monthly basis.

3 Requested Time

We ask to observe 0235+165 and 1749+096 at 5 GHz with the VSOP satellite, each source for two orbits, in order to optimise the u-v coverage. At this stage the flux density of both variable sources is strong enough (3.5 to 4 Jy) to allow good imaging with the VSOP capabilities.
For the aims illustrated in the present proposal it is important for us to have multiepoch observations of these sources. In particular we would like the second epoch to be six months after the first one, and the third epoch about one year after the second one. With the high resolution reached by the requested observations, the proposed time separation should allow us to detect proper motions in the range $3 < \beta_{app} < 30$.
In Section 10 of the AO2 cover sheet we report the preferred array, the minimum array and the suggested epoch for the first observation. The simulations were done by means of the updated version of the program FAKESAT (Murphy, 1995).

4 References

Maraschi L. et al., 1992, in Variability of Blazars, Cambridge Univ. Press, p. 447
Maraschi L., Ghisellini G. & Celotti A., 1992, ApJ 397, L5
Marscher A., 1993, in Astrophysical jets, Cambridge Univ. Press, p. 73
Melia F. & Konigl A., 1989, ApJ 340, 162
Venturi T., 1997, in MemSAIt Vol. 68, N. 1, p. 193