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 : 98 May 7

(2) Proposal title : Compact Sources in Kellerman *et al.* 2CM Sample: Young or Confined?

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(5) Proposal Abstract :

The Kellerman *et al.* 1998 2CM sample shows a remarkable variety of radio sources, but the most remarkable are those *without* extended structure. Given the high angular resolution and dynamic range of the 2 cm sample, and since the redshifts are known, the physical sizes must be smaller than a few par-secs. These sources should be extended unless the components are confined and moving slowly (velocities $< 0.01c$), or are *young*, age < 100 years.
These observations at 6 cm with HALCA will better determine the angular size of the sources, by searching for steep spectrum emission, typical of jets, near the bright core. For the marginally resolved sources, the spectral indices of the components will be determined.
These observations are also important for tests of the HALCA mission performance.

(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: 8

(8) Details of proposed experiments

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Source name (J*hhmm*±*ddmm*)	J2148+0657	J1743-0350	J0238-1636	J0050-0929
Alternative name				
RA(J2000) (hh mm ss.ssss)	21 48 05.459	17 43 58.865	02 38 38.931	00 50 41.317
Dec(J2000) (dd mm ss.ssss)	06 57 38.61	-3 50 04.62	16 36 59.28	-9 29 05.21
Observing frequency band (GHz)	5	5	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)	4.4	3.7	2.8	2.0
Correlated flux (mJy)	4.4	3.7	2.8	2.9
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)				
Related AO1 proposal code(s)				

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

- [x] 2 channel x 16 MHz, 2-bit (Standard mode),
- [ ] Other:

Phase calibration tones:

- [x] 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 :

Desire TWO VSOP orbits with maximum number of different TRACKING stations. Need a few minutes ($\sim$ 30) of 2 cm observations with VLBA, when HALCA is not in contact with a tracking station. Need VLBA + NRAO GB 140ft telescope for comparison of phase stability of Space-Ground and Ground-Ground baselines (No 2CM with 140ft).
Please see attached source list for all 8 sources.

(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

2CM Sample: Young or Confined?

We propose 6cm observations of the "Compact" sources in the Kellerman, Vermeulen, Zensus and Cohen (1998, *A. J.*, **114**:1295) sample of radio sources. The Kellerman *et al.* observations at 2 cm wavelengths with the VLBA have high angular resolution ($\sim$ 1 milli-arcsecond) and dynamic range (1000:1). Their sample of 132 sources shows mostly Single Sided (SS) core-jet morphology, a few Double Sided (DS) structures and 9 sources with "Compact" structure, with maximum angular size less than 1 milli-arcsecond.

The existence of bright "Compact" sources is remarkable. It is known that many radio sources exhibit "super-luminal" motion, so that bulk relativistic motion ($v \sim c$) of particles is an important part of the emission process. For these "Compact" sources, the bulk motions must be confined or the radio sources are young. The Kellerman 2CM sample is not subject to uniform selection criteria, so the "Compact" sub-sample is only representative of a class of sources. However these observations are intended to determine whether there are *any* young or confined radio sources.

Since the redshifts are known for most of these radio sources, the maximum linear size of these sources must be smaller than a few par-secs. If there are relativistic particles producing the radio emission, these sources must be younger than a 100 years old, unless they are confined or perfectly aligned to the observer.

Next we consider the significance of finding such young sources. Since the 2CM sample is not a complete sample, it's parent population is hard to define. However, there are certainly fewer than 1000 extragalactic sources in the sky with brightness greater than 2 Jy at 2 cm. For the arguments below, we assume 1000 sources in the parent population of the 132 sources selected in the 2CM sample. Therefore 0.8 than 100 years.

If there are no other selection biases, then the average age of the parent population i less than 100 years/.008 = 125000 years. This is clearly inconsistent with the ages calculated from the angular sizes of the largest radio sources, which are known to be older than 10^6 years. Therefore, we would look to confinement to explain the small angular scale of the radio sources. The confinement model also has problems. Perlman, Carilli, Stoke and Conway (1996, *A. J.*, **111**:1839) argue that radio source 1413+135 is most likely a *young* radio source. They argue this because the pressure needed to confine an energetic jet would lead to high energy (X-ray) emission which is not seen.

For the 2CM sample sources, EGRET (γ-ray) data are available for two. For 0016+731, no emission is detected by EGRET. For 0235+165, emission is detected by EGRET; for this source confinement might play a role in explaining the small linear size of the radio source.

Since Xu, Readhead, Pearson, Polatidis and Wilkinson (1995, *Ap. J. Suppl.*, **99**:297) find source 0642+449 to be extended ($\sim$ 3 milli-arcseconds) at 6cm, we do not propose re-observation of this source. This leaves 8 sources (see Table 1) in our sub-sample. It is likely that at number of the "Compact" sources will also be extended in high dynamic range 6cm VLBA + HALCA observations. We provide no images of the sample sources, as they appear unresolved in all known observations.

The high angular resolution of HALCA observations is required to search at a lower frequency for jet emission near the radio source core.

Table 1: *"Compact" Sub-Sample from the Kellerman 2CM sample.*

Name	**RA** (J2000)	**Dec.** (J2000)	**Source Type**	**Flux Density** (Jy at 6 cm)
0016+731	00 19 45.787	73 27 30.02	Quasar	1.65
0048-097	00 50 41.317	-9 29 05.21	BL-Lac	1.98
0235+164	02 38 38.931	16 36 59.28	BL-Lac	2.85
0808+019	08 11 26.707	01 46 52.22	BL-Lac	1.40
1308+326	13 10 28.664	32 20 42.78	BL-Lac	1.53
NRAO 512	16 40 29.633	39 46 46.03	Quasar	1.15
1741-038	17 43 58.865	-3 50 04.62	Quasar	3.68
2145+067	21 48 05.459	06 57 38.61	Quasar	4.40

We request 30 minutes of VLBA time at 2 cm, when HALCA is not in contact with a tracking station, in order to allow simultaneous measurement of the spectral indices of these sources. Synthesis is not needed at 2 cm, as Kellerman *et al.* have provided excellent 2cm images.

Observing Plan

The VLBA observations are needed to achieve the high dynamic range needed to search for faint extended emission near the bright core. We request two HALCA orbits in order to obtain the good U-V coverage needed to detect faint emission in the presence of a bright compact component. We would prefer to begin the observations with brightest radio sources.

These observations will be relatively simple to reduce as only nearly point-like sources are expected. However good U-V coverage is needed to confirm this at all orientations to the core of the source.

In order to achieve high dynamic range imaging at high resolution, we request the NRAO 140ft telescope. The HALCA - 140ft baseline will have similar sensitivity to the VLBA-VLBA baselines.

Mission Benefits

In addition to the scientific interest of this sample, these sources are ideal for testing of the HALCA satellite system performance. Because these sources are compact, there will be very little dependence on correlated amplitude with baseline length, allowing a nearly continuous check on the phase stability of the HALCA to ground baselines. We request a sufficient number of orbits to allow inter comparison of different HALCA-tracking station combinations. Schedulers should transfer tracking between stations within a signal view period when possible.

We intend to measure the Space Ground baseline phase stability and compare it with VLBA-VLBA baseline stability, by comparison of the HALCA - 140 ft baseline with "typical" VLBA-VLBA baselines. This comparison is very difficult for extended radio sources, but can be very precisely done with these sources.