A Phase-reference Study of the CSS Radio Source 3C 138 at 15GHz

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Introduction

- Observations
- Data reduction and results
- Summary

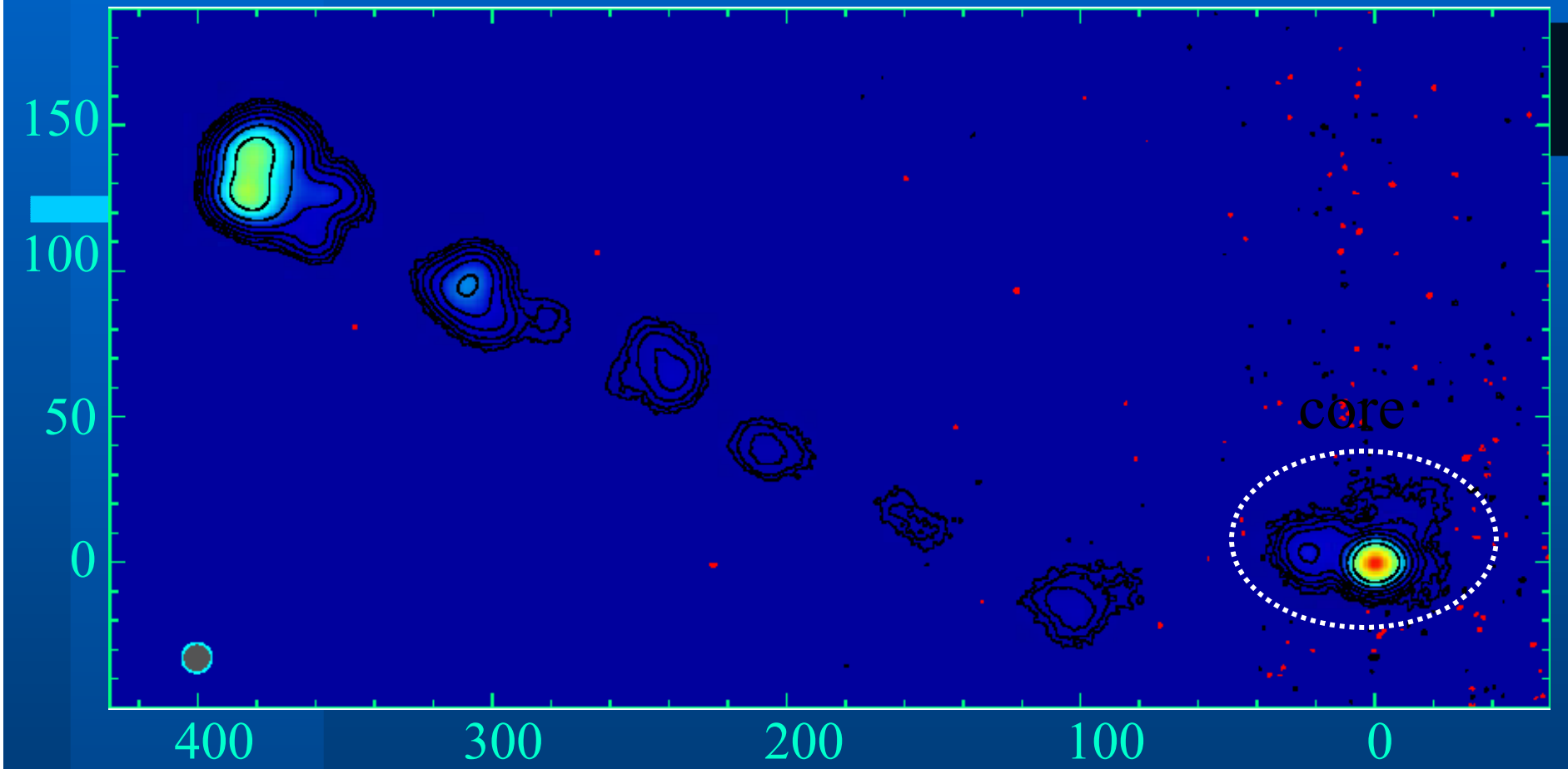
VLBA Observation

- Date: 20th August, 2001
- Multi-frequency (2.3,5,8.6,15Ghz)
- Phase-referenced observation at 15GHz only
- Target source: 3C138
- Calibrator: 0528+134

Target source: 3C 138

- RA $05^h21^m9^s.886$ Dec 16°38′22″
- m_v=18.84 , z=0.759
- Compact steep spectrum (CSS) source Spectral index is 0.65
- A complicated lobe-dominated source
- 15GHz single-dish flux density = 1.63Jy

Fig. 1 Large scale structure of 3C138 at 5GHz



- Uniform weighting
- Beam 10 × 10(mas) at 0°
- Contours: 1mJy/beam × (-1, 1, 2, 4, 8, 16, 32,64)
- Map peak : 0.21Jy /beam

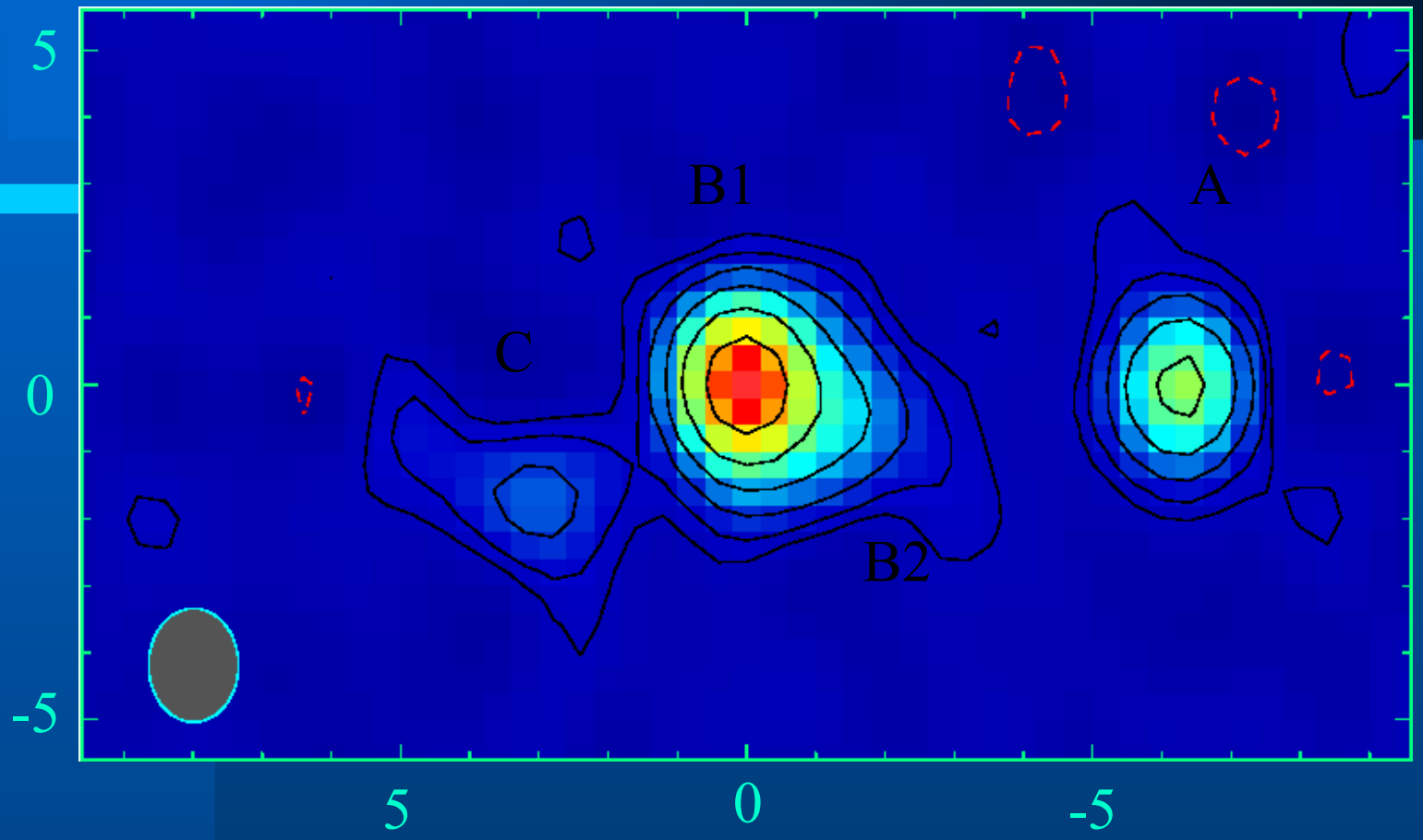
Calibrator: 0528+134

- RA $05^h30^m56^s.4167$ Dec $13°31'55''.149$
- $z=2.06$, $m_v=20$
- Compact strong γ-ray quasar
- Separation from 3C 138 is 3°.91

Data reduction--1

We first did a global fringe fitting to 3C138 data directly, then made a hybrid map from the detected visibility data.

Fig. 1 Hybrid map of 3C 138 at 15GHz



- Uniform weighting
- beam1.7 × 1.3(mas) at 0°
- Contours: 2mJy/beam × (-1, 1, 2, 4, 8, 16, 32)
- Map peak : 62.0mJy /beam

Data reduction--2

Phase-referenced technique

- Map 0528+134 with high dynamic range
- The clean components of 0528+134 were fed back to the phase self-calibration process to estimate the antenna-based residuals
- Apply the resulting solution to the visibility data of 3C 138

Fig. 2 VLBI map of 0528+134 at 15GHz

- Uniform weighting
- Map peak 1.49 Jy/beam
- Beam: 0.812 × 0.395mas at -7.39°.
- Contour 13 mJy/ beam ×(-1, 1, 2, 4, 8, 16, 32, 64)
- Dynamic range: ~400
- The integrated flux density of the jet accounts for 8.6% of the total flux density, i.e. core-dominated source

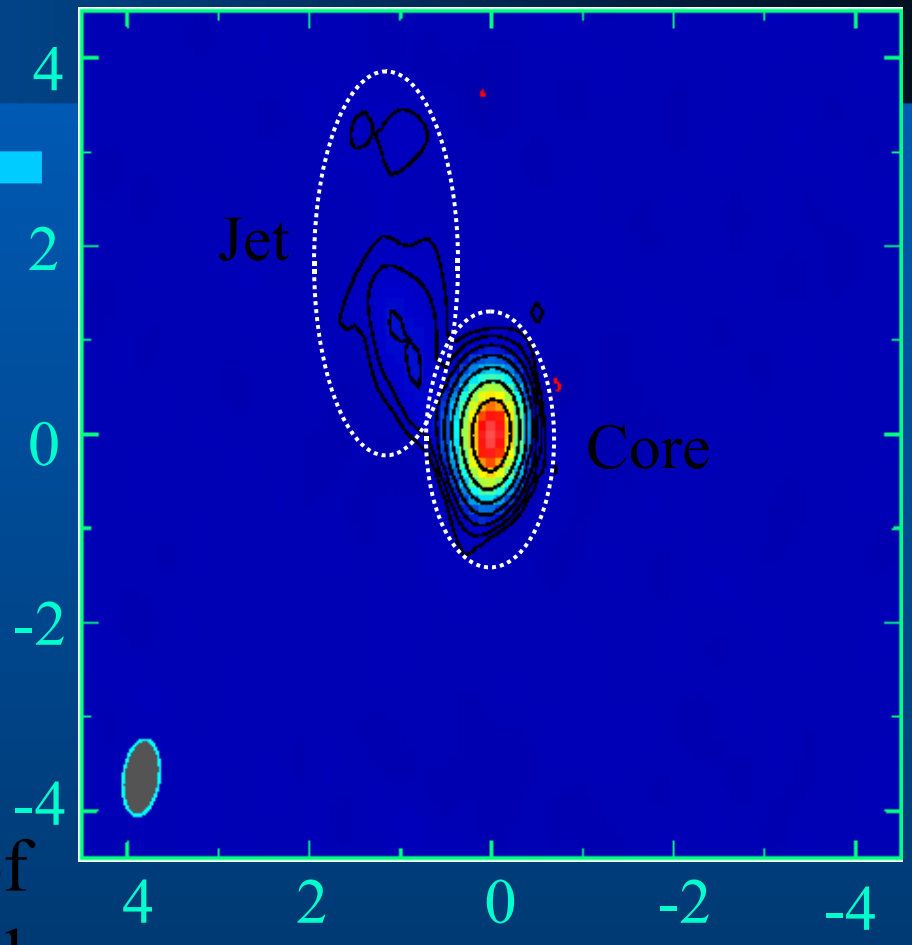
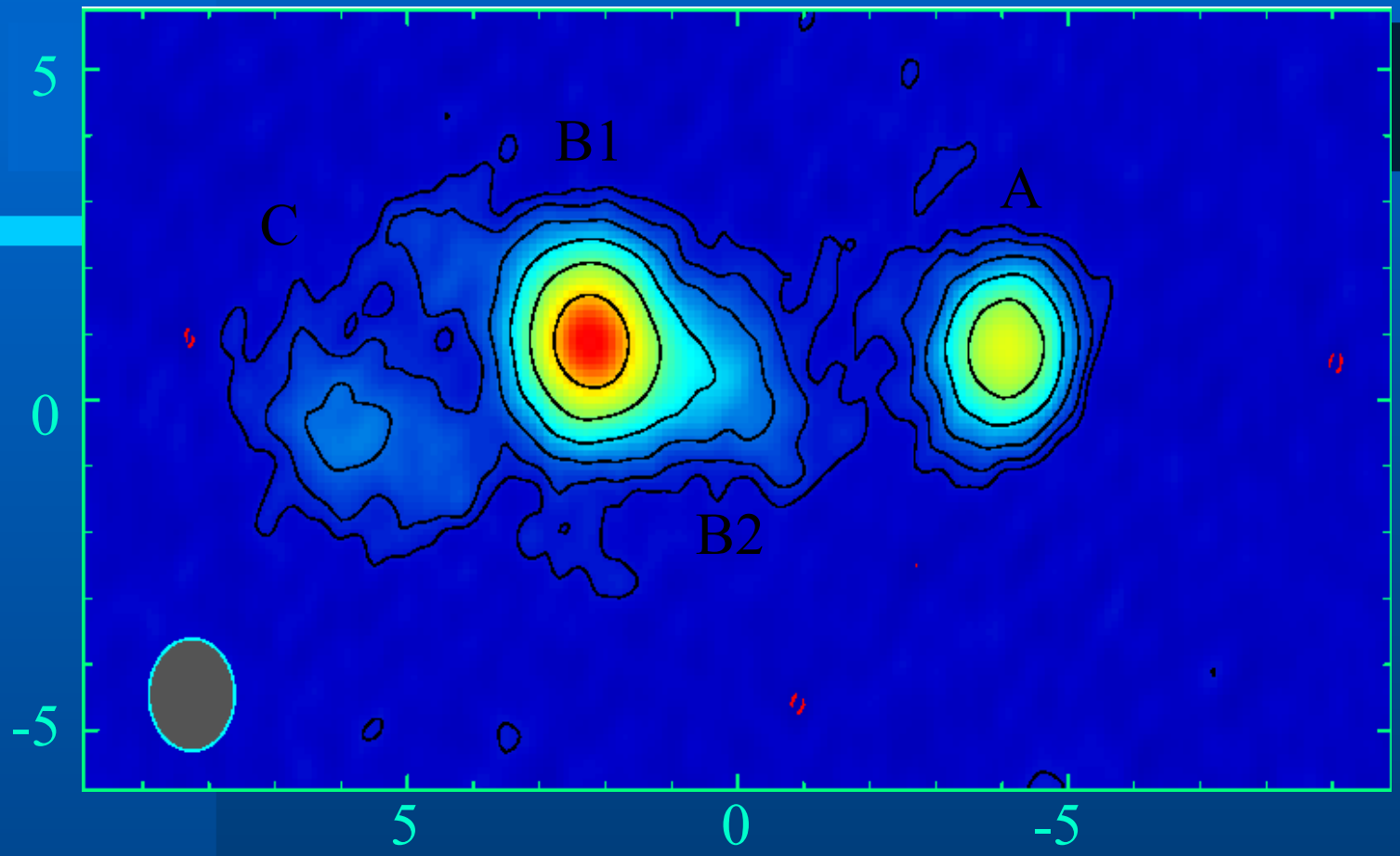
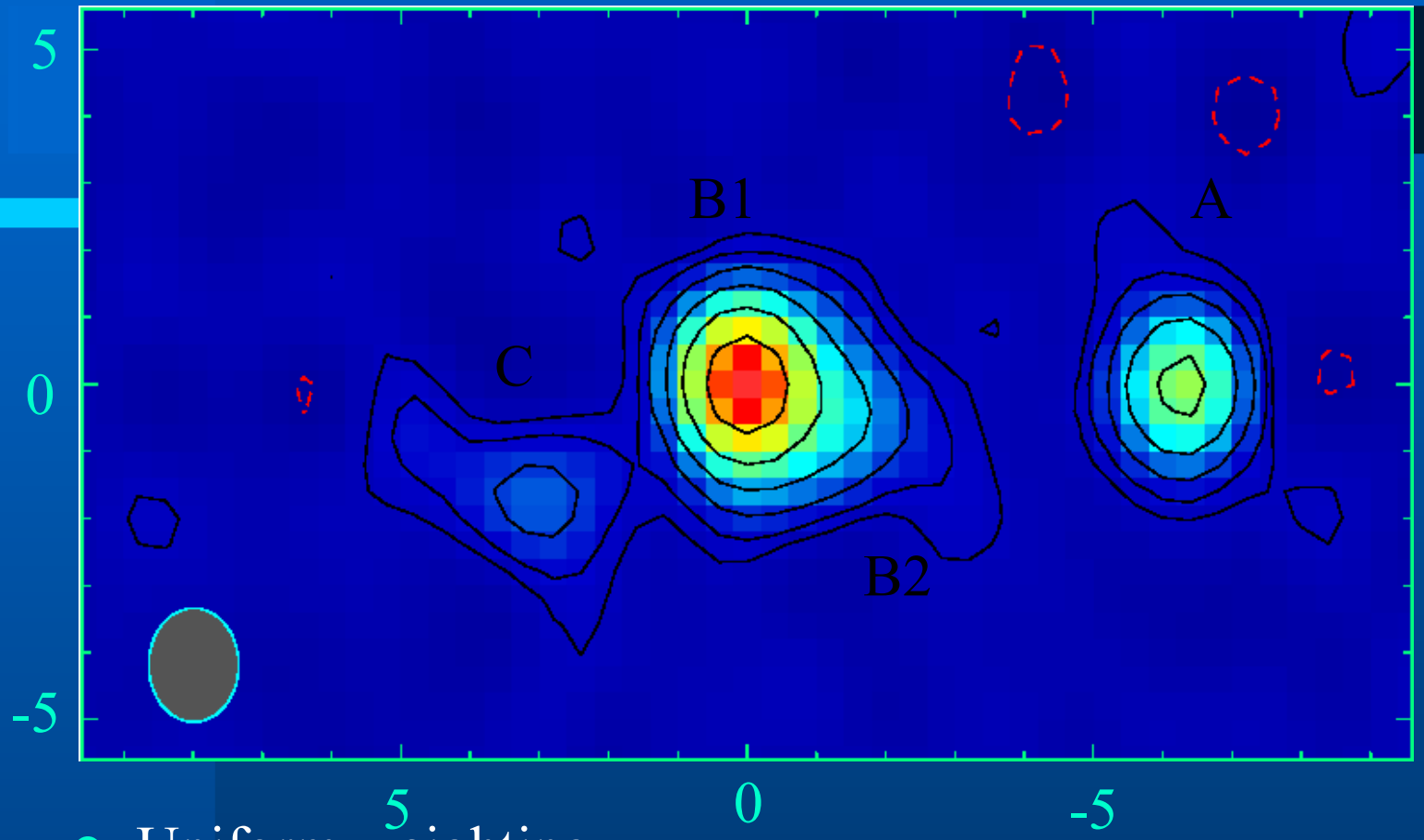


Fig. 3 Phase-referenced map of 3C 138 at 15GHz



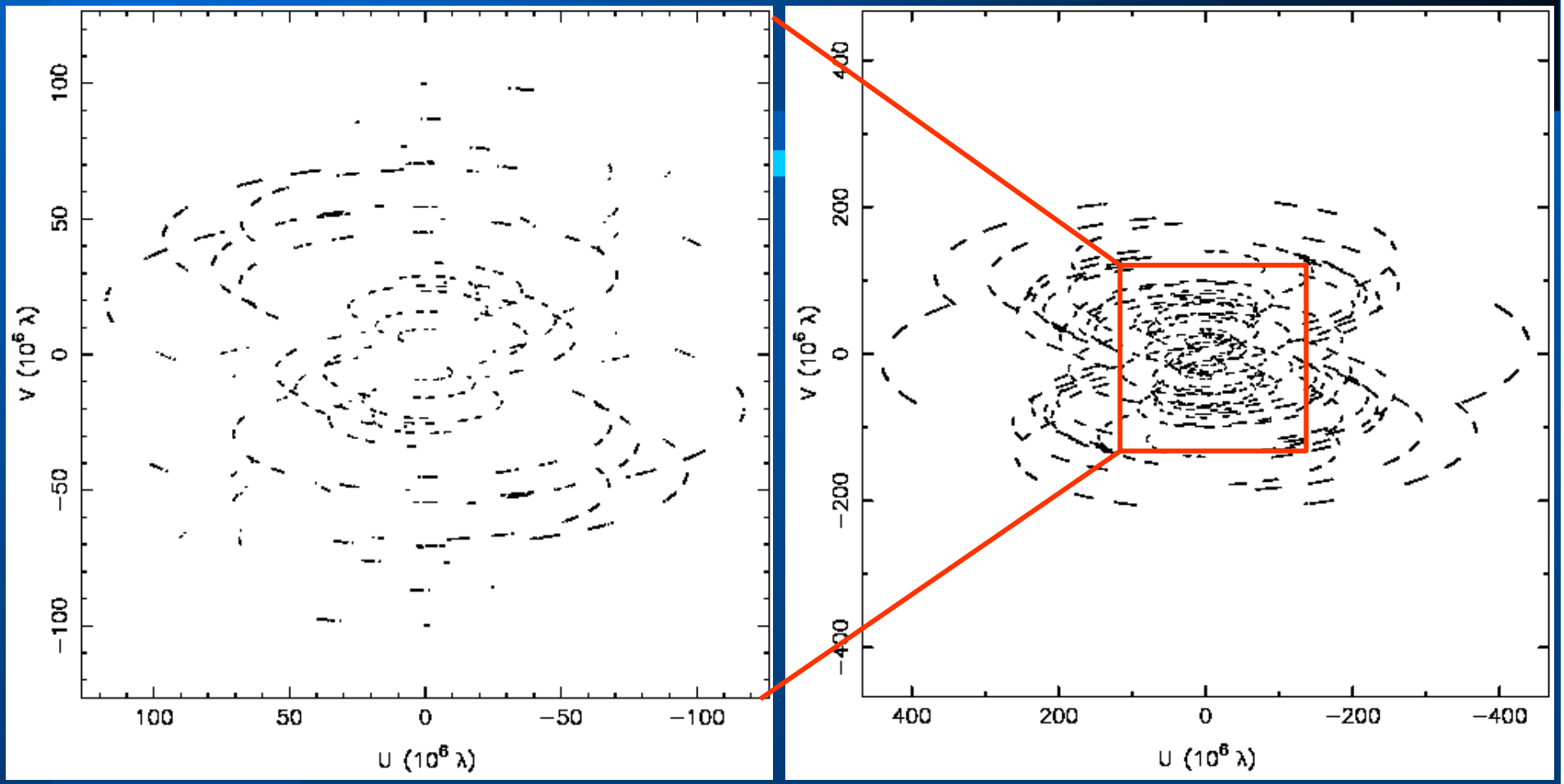
- Uniform weighting
- beam1.7 × 1.3(mas) at 0°
- Contours: 2mJy/beam × (-1, 1, 2, 4, 8, 16, 32)
- Map peak : 55.1mJy/beam

Fig. 1 Hybrid map of 3C 138 at 15GHz



- Uniform weighting
- beam1.7 × 1.3(mas) at 0°
- Contours: 2mJy/beam × (-1, 1, 2, 4, 8, 16, 32)
- Map peak : 62.0mJy /beam

Fig. 4 *uv*-coverage



- (left) *uv*-coverage of Hybrid mapping
- (right) *uv*-coverage of Phase-reference mapping

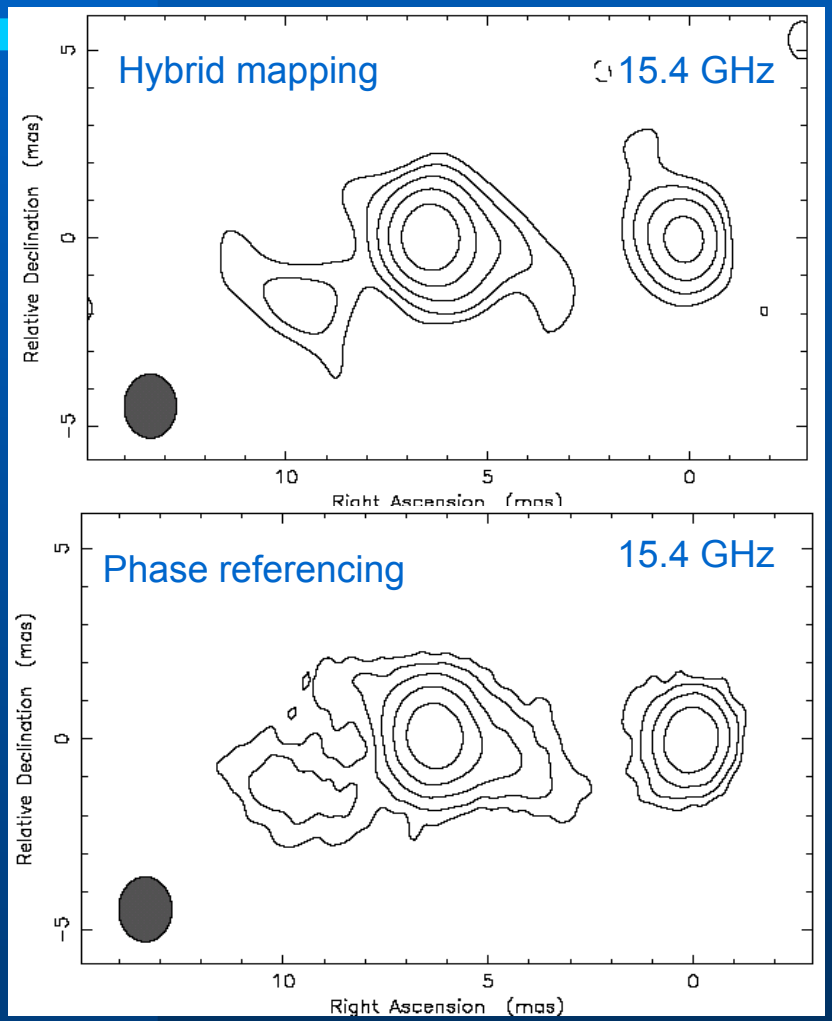
Model-fitting to Hybrid map

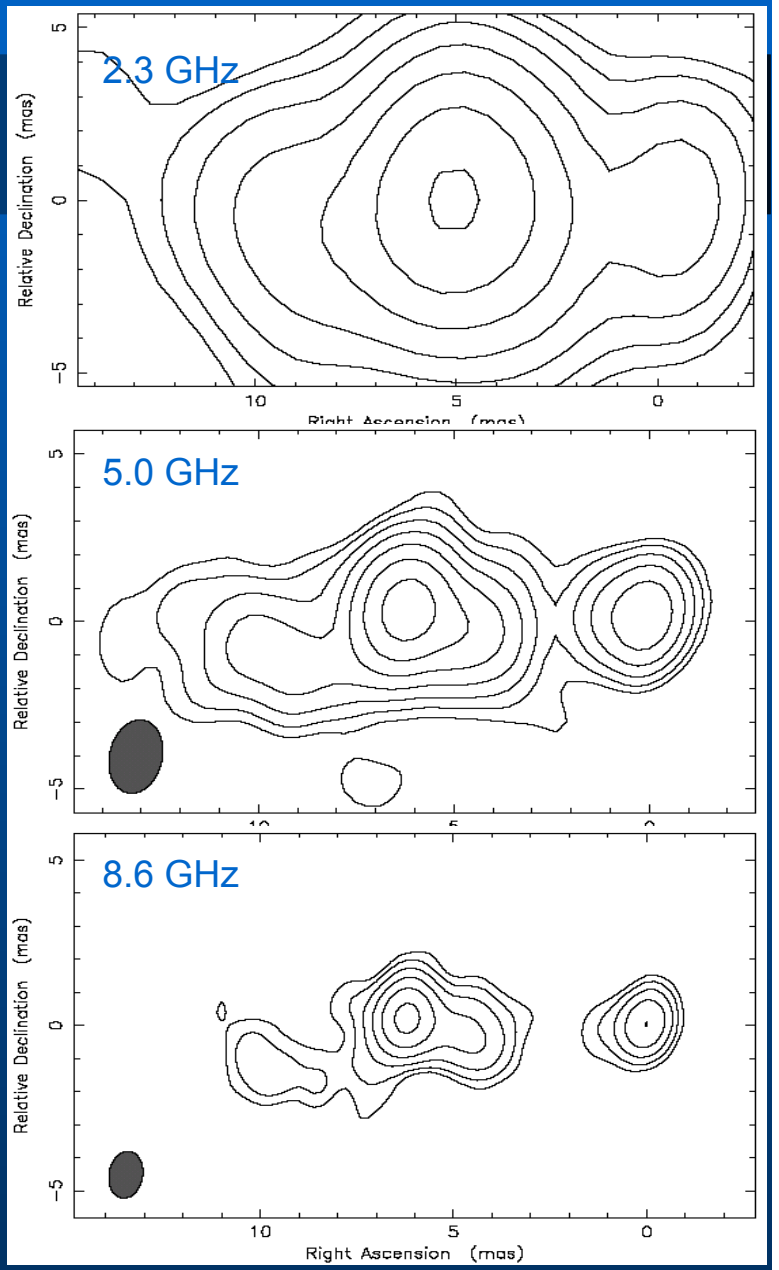
Component	S/(Jy)	r (mas)	PA(°)	a/(mas)
A	0.027	0	0	0.27
B2	0.024	4.93	94.3	1.62
B1	0.067	6.36	81.9	0.44
C	0.011	9.51	99.6	1.47

Model-fitting to Phase-referenced map

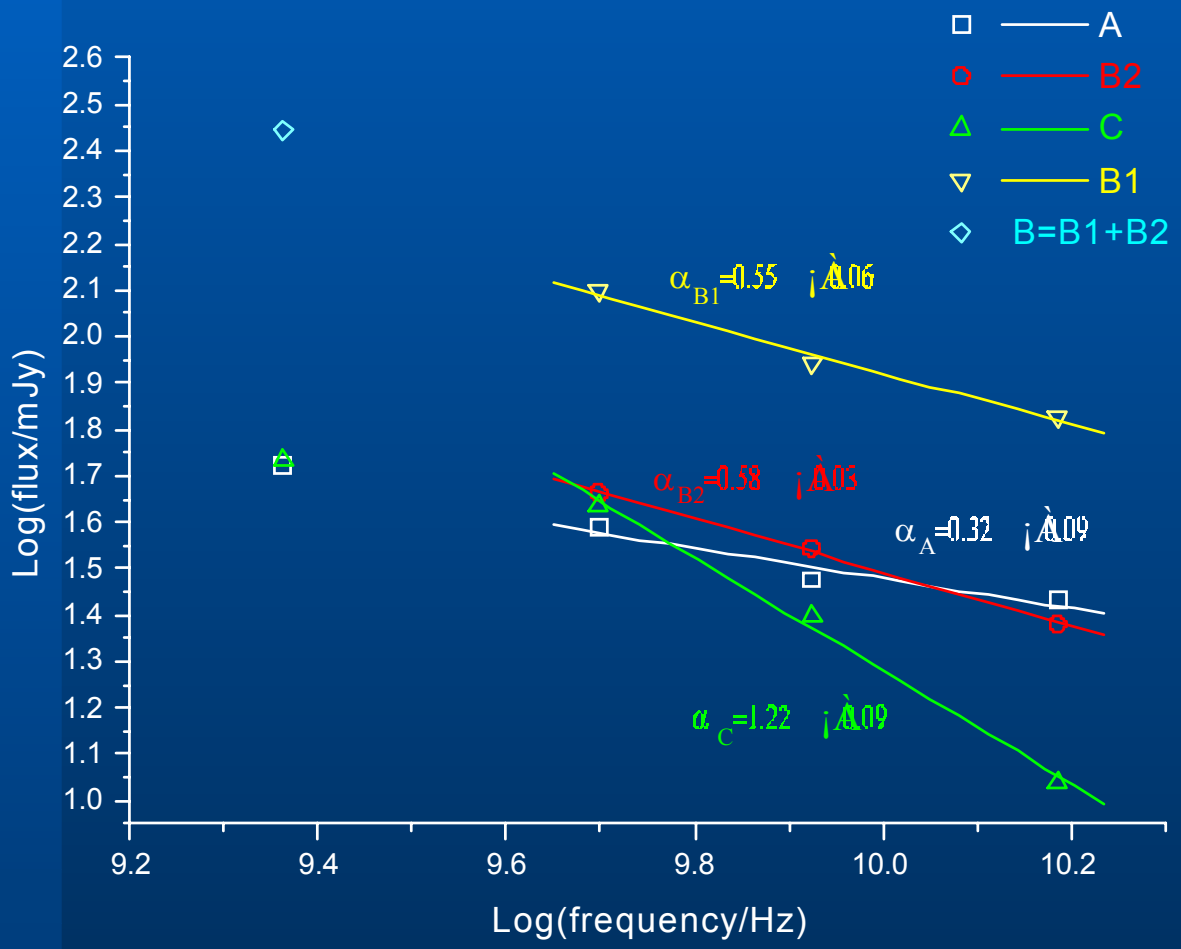
Component	S/(Jy)	r(mas)	PA(°)	a/(mas)
A	0.031	0	0	0.11
B2	0.021	4.88	94.2	1.47
B1	0.065	6.33	88.8	0.53

Central core region





Spectrum


A
B2
C
B1
B=B1+B2
α_{B1}=0.55 ¡À0.06
α_{B2}=0.58 ¡À0.03
α_{A}=0.32 ¡À0.09
α_{C}=1.22 ¡À0.09
Log(flux/mJy)
Log(frequency/Hz)
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
9.2
9.4
9.6
9.8
10.0
10.2

Summary

- The results at 15GHz are consistent with that at other frequencies.
- Future work

  Multi-frequency Phase-reference observation
  - To confirm the position of the core
  - To probe the superluminal motion
  - To study frequency-dependence of the core position