Study of mutual occultation phenomena of the Galilean satellites at radio wavelengths

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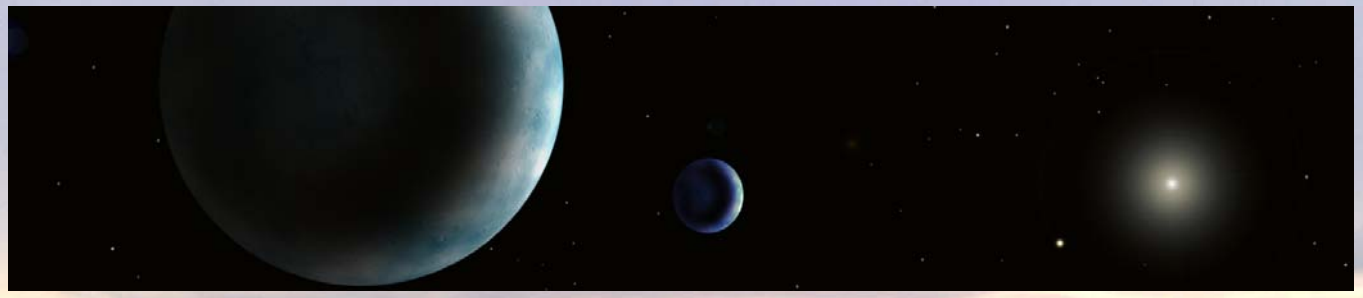
The Radio Occultation research program performed with INAF-IRA radiotelescopes

It is composed of two parts:

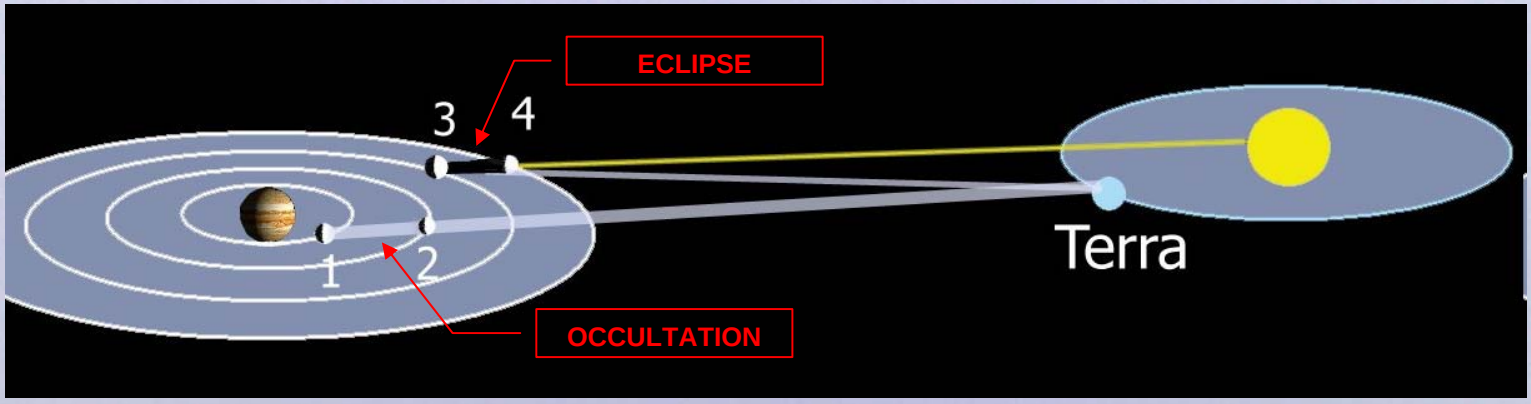
- Lunar Radio Occultation (LRO) program

- Satellite by Satellite Occultation (SSO) program

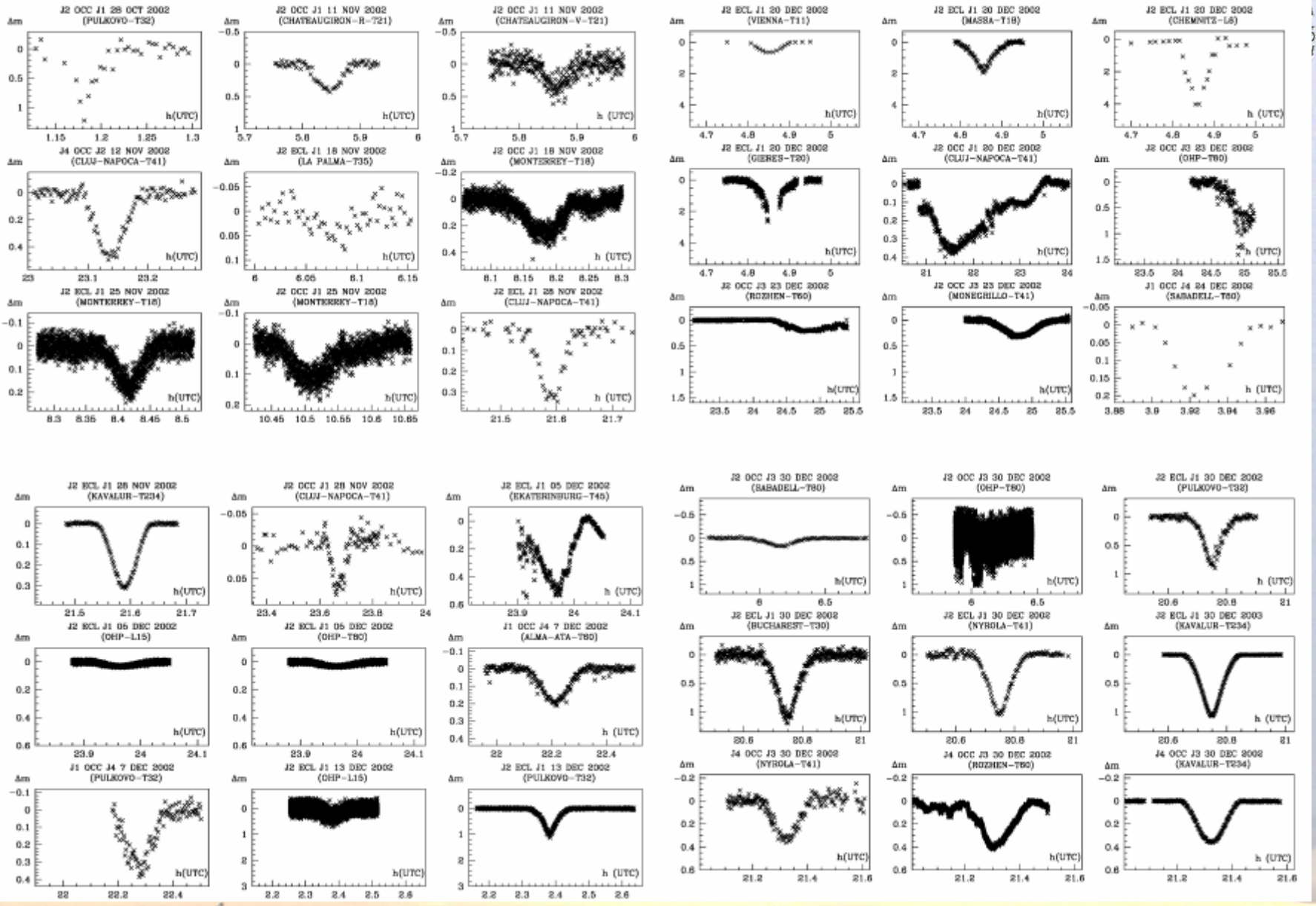


Satellite by Satellite Occultation program

It includes the observation of SSO events, as well as mutual occultations phenomena of Jupiter satellites (PHEMU).



These observations are aimed to measure the radio flux variation during the occultation and to derive surface spatial characteristics such as Io's hot spots.


J2 OCC J1 28 OCT 2002 (PULKOVO-T32)
J2 OCC J1 11 NOV 2002 (CHATEAUGIRON-R-T21)
J2 OCC J1 11 NOV 2002 (CHATEAUGIRON-V-T21)
J2 ECL J1 20 DEC 2002 (VIENNA-T11)
J2 ECL J1 20 DEC 2002 (MASSA-T18)
J2 ECL J1 20 DEC 2002 (CHEMNITZ-L8)
J4 OCC J2 12 NOV 2002 (CLUJ-NAPOCA-T41)
J2 ECL J1 18 NOV 2002 (LA PALMA-T35)
J2 OCC J1 18 NOV 2002 (MONTERREY-T18)
J2 ECL J1 20 DEC 2002 (GIERES-T20)
J2 OCC J1 20 DEC 2002 (CLUJ-NAPOCA-T41)
J2 OCC J3 23 DEC 2002 (OHP-T80)
J2 ECL J1 25 NOV 2002 (MONTERREY-T18)
J2 OCC J1 25 NOV 2002 (MONTERREY-T18)
J2 ECL J1 25 NOV 2002 (CLUJ-NAPOCA-T41)
J2 OCC J3 23 DEC 2002 (ROZHEN-T60)
J2 OCC J3 23 DEC 2002 (MONEGHILLO-T41)
J1 OCC J4 24 DEC 2002 (SABADELL-T80)
J2 ECL J1 28 NOV 2002 (KAVALUR-T234)
J2 OCC J1 28 NOV 2002 (CLUJ-NAPOCA-T41)
J2 ECL J1 05 DEC 2002 (EKATERINBURG-T45)
J2 OCC J3 30 DEC 2002 (SABADELL-T80)
J2 OCC J3 30 DEC 2002 (OHP-T80)
J2 ECL J1 30 DEC 2002 (PULKOVO-T32)
J2 ECL J1 05 DEC 2002 (OHP-L15)
J2 ECL J1 05 DEC 2002 (OHP-T80)
J1 OCC J4 7 DEC 2002 (ALMA-ATA-T80)
J2 ECL J1 30 DEC 2002 (BUCHAREST-T30)
J2 ECL J1 30 DEC 2002 (NYROLA-T41)
J2 ECL J1 30 DEC 2003 (KAVALUR-T234)
J1 OCC J4 7 DEC 2002 (PULKOVO-T32)
J2 ECL J1 13 DEC 2002 (OHP-L15)
J2 ECL J1 13 DEC 2002 (PULKOVO-T32)
J4 OCC J3 30 DEC 2002 (NYROLA-T41)
J4 OCC J3 30 DEC 2002 (ROZHEN-T60)
J4 OCC J3 30 DEC 2002 (KAVALUR-T234)
Δm
h(UTC)
h (UTC)

Previous radio observations of Io satellite (VLA)

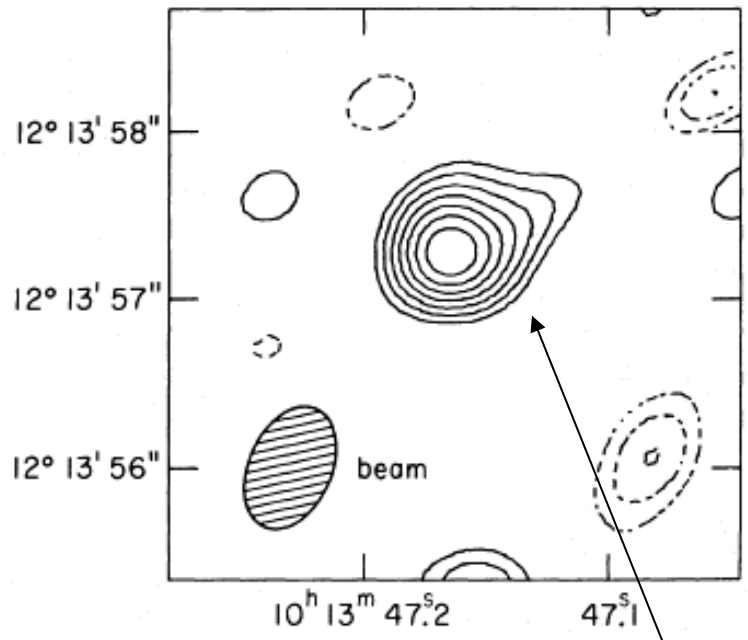


FIG. 1a

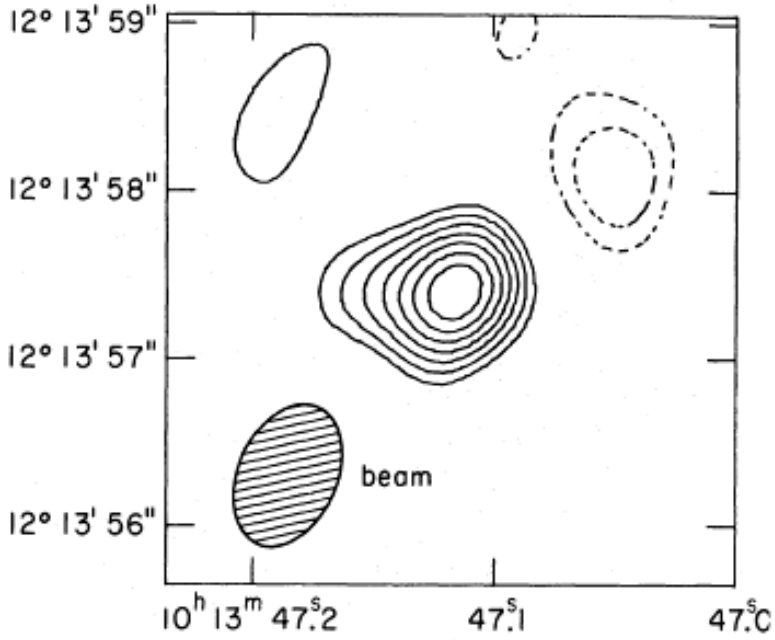


FIG. 1b

FIG. 1.—Maps of Io at (*a*) 2 cm and (*b*) 6 cm. The contour intervals are 30%–90% in steps of 10% of the peak intensity, which is 6.7 mJy/beam at 2 cm and 0.95 mJy per beam at 6 cm. Dashed contours indicate negative values. The half-power beam area is shown in each map.

Unresolved surface details

Io Hot Spots in 1991 (optical and infrared)

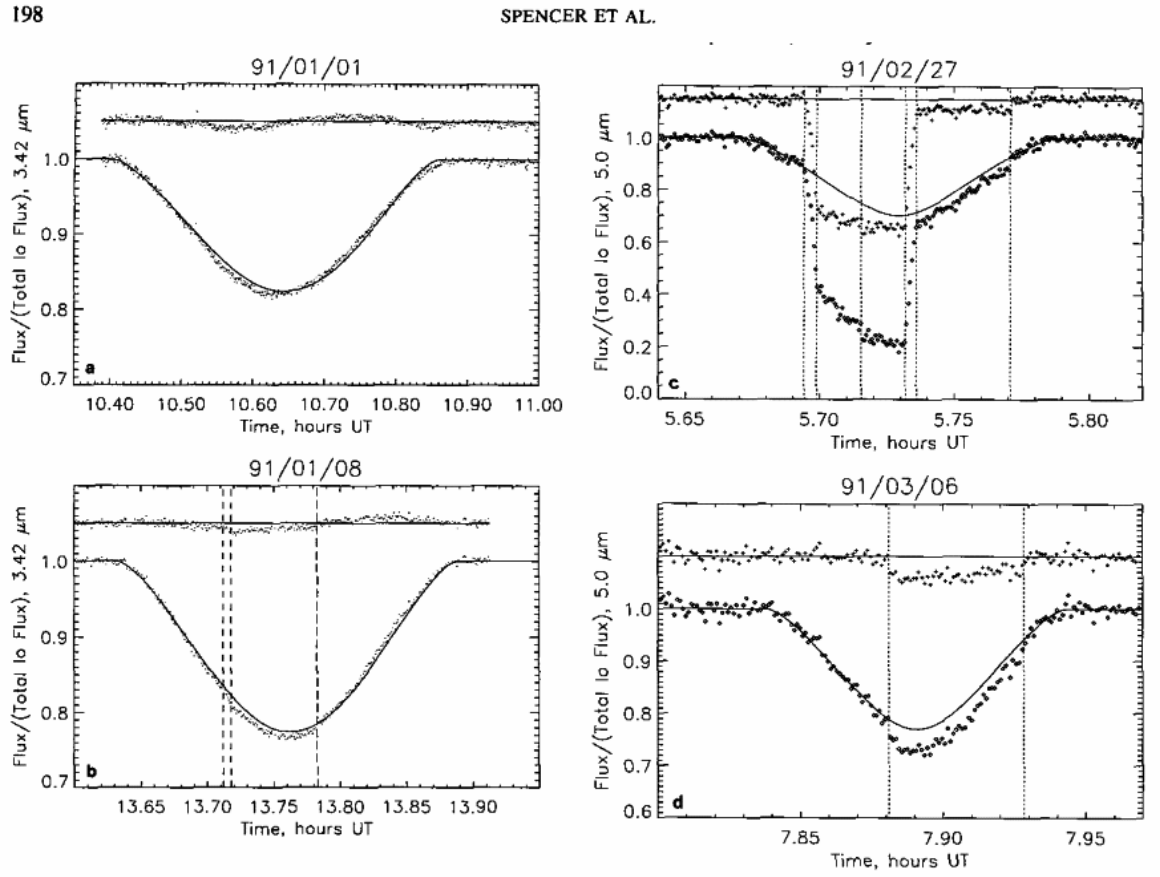
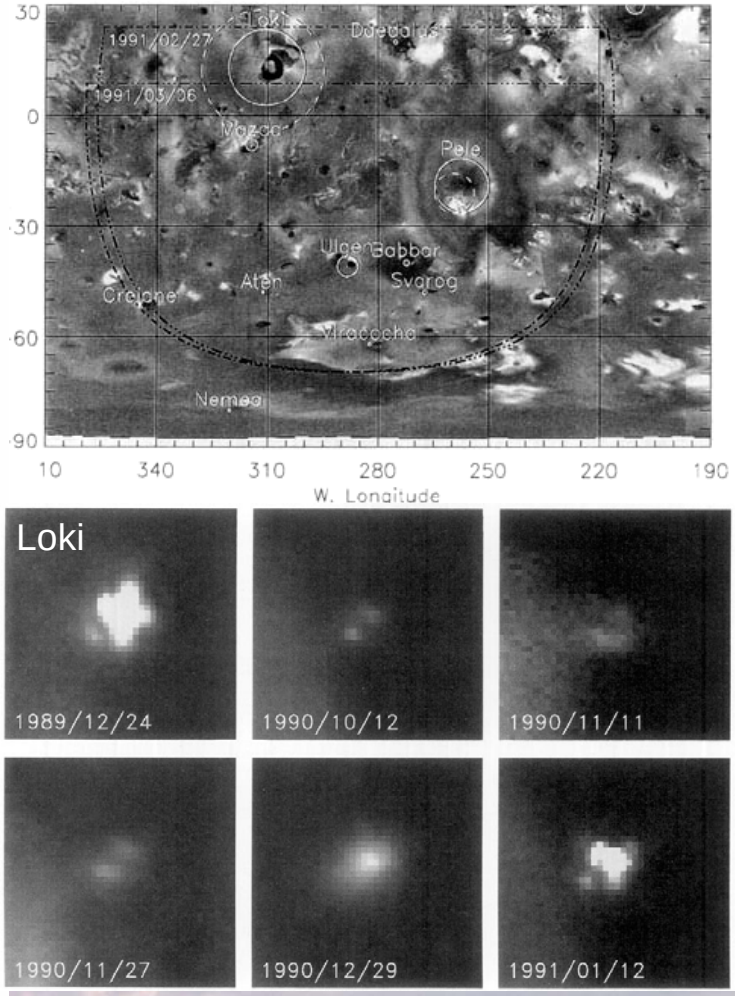
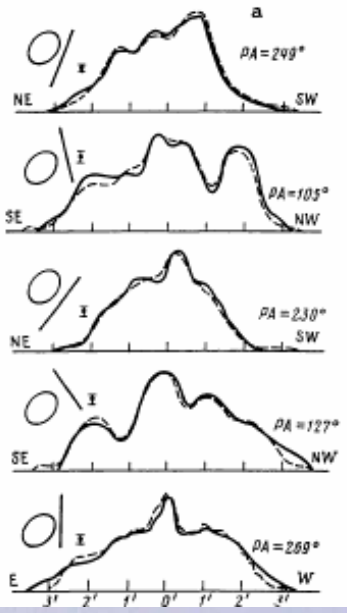
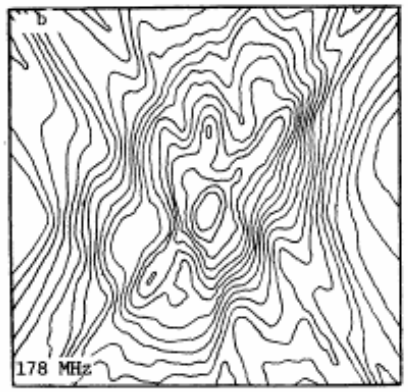


FIG. 2. The four Europa occultation lightcurves, along with model lightcurves derived from the Goguen empirical ephemeris, with residuals from the model plotted at the top of each panel, displaced vertically for clarity. Dashed vertical lines show the times of possible or definite hot spot occultations: pairs of lines show the duration of the hot spot occultation if this is resolved. (c and d) Diamonds represent the original data and crosses represent the residuals.



Radio occultation technique





Title: Radio Images of the Crab Nebula Based on Lunar Occultation Data
Authors: Agafonov, M. I., Ivanov, V. P., & Podvoiskaya, O. A.
Journal: SOVIET ASTR.(TR: A. ZHURN.) V.34, NO. 3/MAY, P.275, 1990

FIG. 3. Profiles of the strip distributions (a) used to construct an image of the Crab Nebula at 178 MHz (the control profiles are dashed; the position of the lunar limb relative to the radio source is shown on the left) and an uncorrected map of the nebula at 178 MHz (b).

Two-dimensional images of the Crab Nebula at 750 and 178 MHz with angular resolution of 20 x 35 and 45 x 65 arcsec, respectively, have been restored on the basis of occultation profiles for 1982-1983.

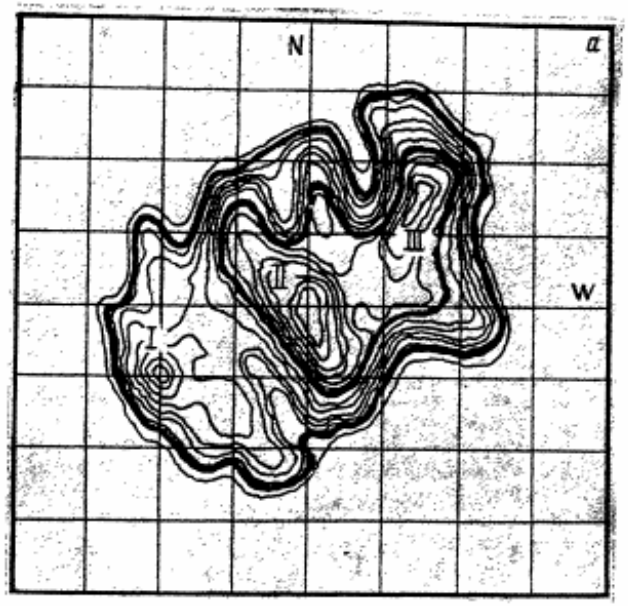
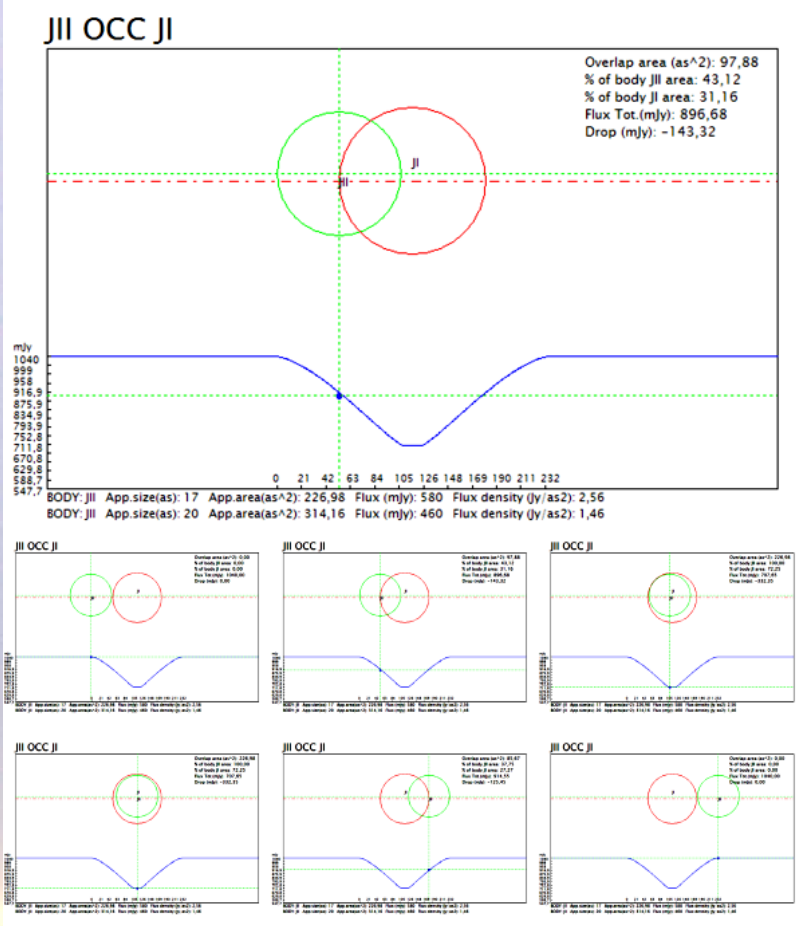
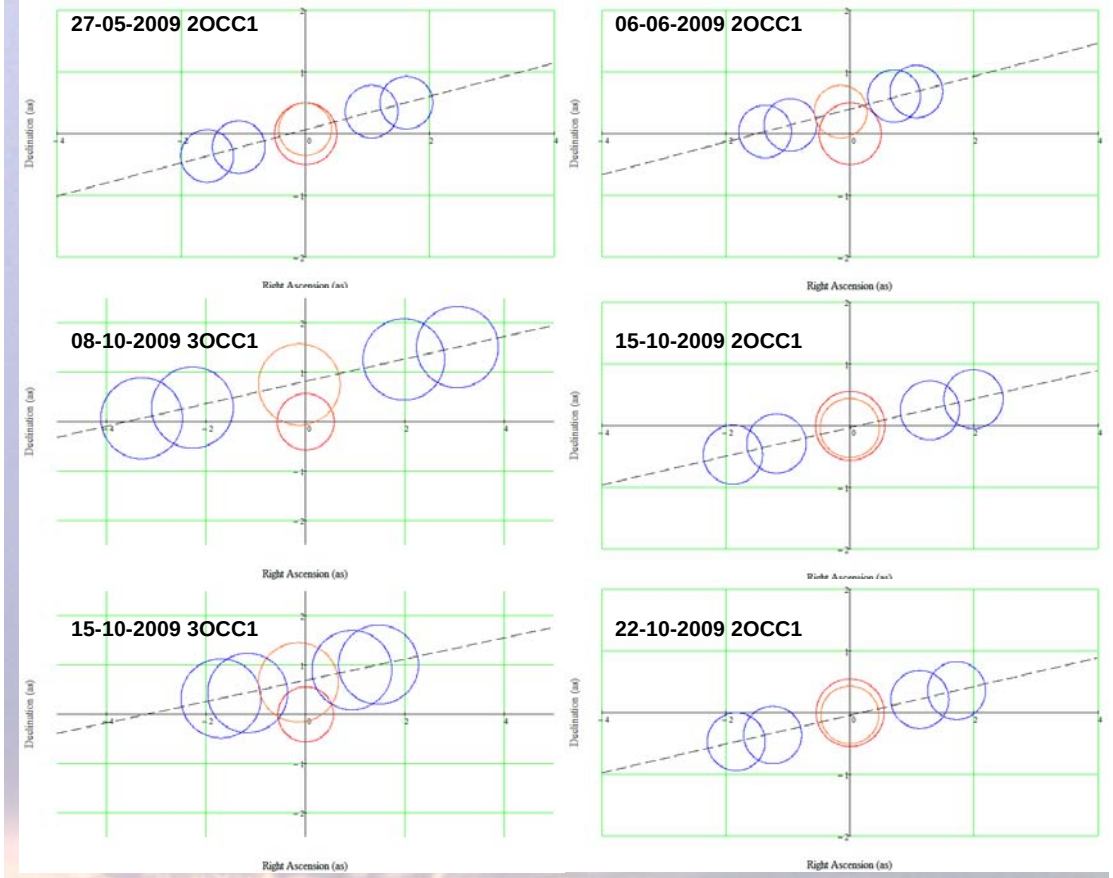


FIG. 5. Result of reconstruction by the TC-CLEAN method at 178 MHz (the uniform step of isophotes on the map is ~7% of the peak intensity).

Satellite by Satellite Occultation program

Simulation of occultation events are performed by “ad hoc” softwares based on NASA JPL ephemerides data.





Satellite by Satellite Occultation program

- Further measurements are already planned to confirm previous results and explain observed phenomena.
- Simultaneous measurements performed at optical and/or IR wavelengths could help to explain observed phenomena (collaborations are welcome!).
- Next Io's occultation events:

DATE (TE) DU MAXIMUM AN MS JR	PHENOMENE	DEBUT PENOMBRE H M S	DEBUT OMBRE/OCC H M S	DEBUT TOTALITE H M S	MAXIMUM H M S	FIN TOTALITE H M S	FIN OMBRE/OCC H M S	FIN PENOMBRE H M S	MAGNITUDE	DUREE S	DIST.A SAT. (RS)	DIST. IMPACT (")	ELEV. MED deg	ELEV. NOTO deg
2009 10 8	3 OCC 1 P		17 49 34.		17 51 6.		17 52 38.		0.030	184	3.3	1.189	+25	+33
2009 10 15	2 OCC 1 A		17 19 53.		17 21 44.		17 23 35.		0.426	221	1.5	0.036	+24	+33
2009 10 15	3 OCC 1 P		20 28 26.		20 30 33.		20 32 40.		0.071	254	3.9	1.008	+25	+30
2009 10 22	2 OCC 1 P		19 28 28.		19 30 19.		19 32 10.		0.426	223	1.7	0.079	+27	+33
2009 11 16	2 OCC 1 A		15 12 32.		15 14 29.		15 16 26.		0.426	234	2.6	0.015	+25	+33
2009 11 23	2 OCC 1 A		17 28 55.		17 30 54.		17 32 53.		0.426	238	2.8	0.055	+28	+34
2009 11 28	3 OCC 1 P		13 44 35.		13 46 42.		13 48 49.		0.025	254	5.4	1.036	+20	+28
2009 11 30	2 OCC 1 P		19 46 53.		19 48 53.		19 50 53.		0.388	240	3.1	0.142	+12	+14
2009 12 11	2 OCC 1 P		11 16 40.		11 18 38.		11 20 37.		0.281	237	3.5	0.298	+07	+13
2009 12 18	2 OCC 1 P		13 38 22.		13 40 16.		13 42 9.		0.201	227	3.7	0.413	+27	+35
2009 12 25	2 OCC 1 P		16 1 31.		16 3 14.		16 4 58.		0.123	206	4.0	0.533	+28	+35
2010 1 1	2 OCC 1 P		18 26 10.		18 27 34.		18 28 58.		0.054	169	4.2	0.655	+10	+11
2010 3 21	2 OCC 1 P		9 53 8.		10 8 35.		10 24 30.		0.397	1882	1.4	0.112	+38	+46
2010 3 28	2 OCC 1 P		8 44 24.		9 1 15.		9 17 24.		0.400	1980	1.3	0.109	+32	+31

Thank you