

Reconsideration for causalities of occurrence features of Io-related Jupiter's radio emission

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The following questions; 'What kind of magneto-ionic wave Jupiter's auroral radio emission is?' and 'How the radio emission is generated?' have been long years of subjects. I have investigated the subjects based on numerical calculations using several kinds of magnetic field and plasma density models, however, the questions have not been resolved yet: a hypothesis of a special energy transporter which does not meet with the observation results was needed. Recently Jupiter's new magnetic field model 'JRM09' was proposed based on the JUNO Jupiter explorer conducting in-situ magnetic field measurements near Jupiter (Connerney+, GRL, 2018). We have tried to make a 3D raytracing analysis for Io-DAM using the JRM09 model. The preliminary analyses show that R-X mode waves are preferable as Io-DAM and the JRM09 model gives more natural explanations for the origin of Io-DAM, though there still remain some questions on restriction of 'Io-DAM' and on origin of Io-C; i.e., some additional energy input process(es) so as to meet the ray emitting conditions with the observed Io-DAM sources.

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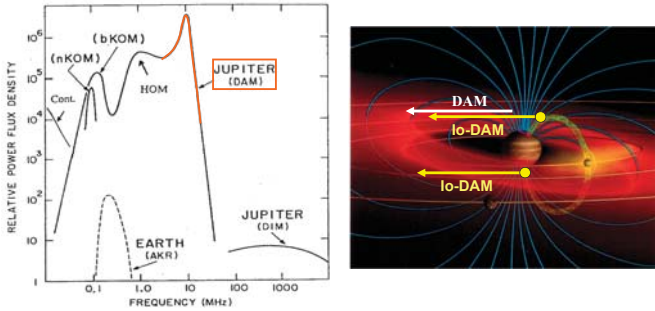


Fig. Spectral profile of Jupiter's radio emission (Kaiser, 1993)

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Io-DAM : Unexplained Characteristics

1. Occurrence probability ... Localized Sources

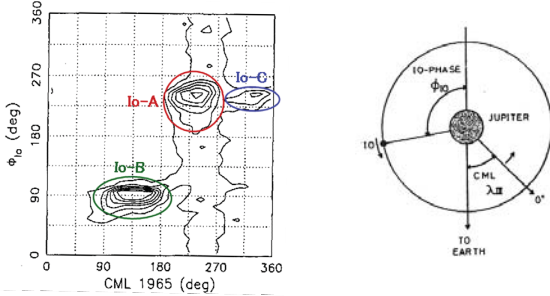


Fig. Occurrence prob. for DAM (obs. by Tohoku Univ. in 1974-1994)

2. Polarization ... RH elliptical pol.

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ABSTRACT

The following questions; 'What kind of magneto-ionic wave Jupiter's auroral radio emission is?' and 'How the radio emission is generated?' have been long years of subjects. I have investigated the subjects based on numerical calculations using several kinds of magnetic field and plasma density models, however, the questions have not been resolved yet: a hypothesis of a special energy transporter which does not meet with the observation results was needed. Recently Jupiter's new magnetic field model 'JRM09' was proposed based on the JUNO Jupiter explorer conducting in-situ magnetic field measurements near Jupiter (Connerney+, GRL, 2018). We have tried to make a 3D raytracing analysis for Io-DAM using the JRM09 model. The preliminary analyses show that R-X mode waves are preferable as Io-DAM and the JRM09 model gives more natural explanations for the origin of Io-DAM, though there still remain some questions on restriction of 'Io-DAM' and on origin of Io-C.

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Purpose of this study

Origin of Io-DAM ... No reliable direct obs.

- Investigation of origin (generation & propagation processes) of Io-DAM using numerical analyses ("ray trace", "polarization trace")
- Magneto-ionic mode? (R-X or L-O?)
- Generation conditions? (source location, initial ray direction)
- Plasma conditions in source & propagation regions? ... next step (polarization analysis)

Previous numerical analysis for Io-DAM

Method: 3D Ray & Polarization tracing (Misawa+, 2008):

- model of magnetic field : VIP4 (Connerney+ 1998)
- model of plasma density : $N_{e,max} = 6 \times 10^5 [cm^{-3}]$, $H \sim 960 km$ (Eshleman+ 1979)
- wave mode : R-X & L-O

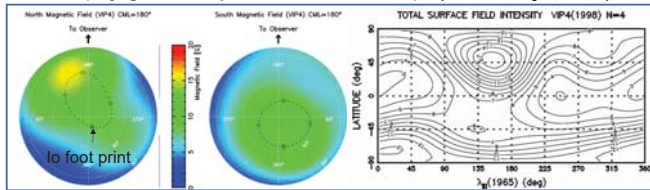
Results:

- wave mode : "R-X"
- wave direction : $\sim 90^\circ$ to B
- lead angle : $\sim 20^\circ \sim$
- special requirements : "selective energy input" for the longitudes of northern Io-DAM sources

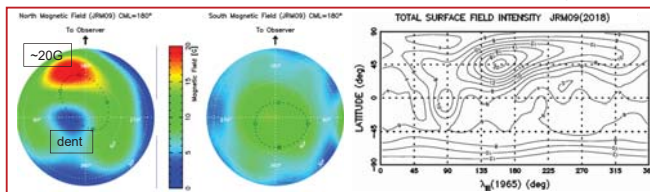
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Comparison between VIP4(1998) & JRM09(2018)

● "VIP4(Voyager, Io foot prints, Pioneer, 4th order)" (Connerney+, 1998)



● "JRM09(Juno Reference Model through Perijove 9)" (Connerney+, 2018)



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Explanation of 'Observable Ray Map' & 'Lead Angle'

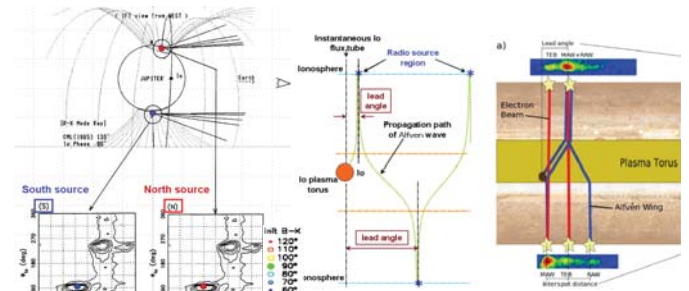


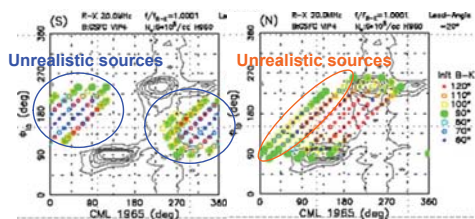
Fig. 'Observable Ray Map'

Fig. Observed 'Lead Angle'. (Bonfond et al., 2008 / Hess et al., 2011)

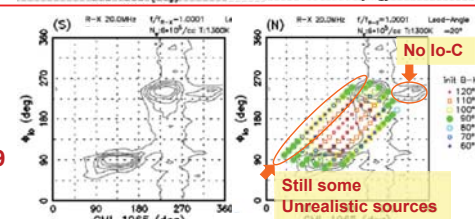
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Results for mag. models of VIP4 & JRM09

✖ Previous res. using VIP4



Result of this study using JRM09



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Summary

● Purpose: Investigation of origin (source location, wave mode, generation & propagation conditions) of Jupiter's Io-DAM emission

● Method: 3D raytracing

- Conditions:
- R-X & L-O mode waves from S & N hemis.
 - Including Lead-angle
 - Emission to all-directions
 - Diffusive equilibrium Ne model
 - New mag. Model "JRM09"

● Result: Io-DAM is generated:

- R-X mode from N-hemisphere
- Lead-angle $\sim 20^\circ \sim$
- Cone half angle $\sim 90^\circ \sim$
- 'JRM09' like mag.-field. is more plausible. (in tenuous Ne ionosphere (by Pol.-analysis))

However, there are still remaining questions:

- Some additional conditions to restrict 'Io-DAM source'?
- More precise mag.-field model may be further needed?

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