Past and future observations of Jupiter with Cassini/RPWS

L. Lamy, C. Louis, P. Zarka, B. Cecconi
LESIA, CNRS-Observatoire de Paris
1- Catalog of Jovian emissions recorded outside the flyby period

2- Search for planet-satellites interactions during the flyby
   (a) Using time series of power
   (b) Using ExPRES simulations
Few studies of Jupiter auroral radio emissions during the 2000-2001 flyby: e.g.
- Beam width of HOM-DAM emissions (Kaiser et al., 2000)
- Solar wind control of HOM-DAM (Gurnett et al., 2002; Hess et al., 2014)
- Average spectrum over 3kHz-16MHz (Zarka, 2004)
- …
1- Catalog of Jovian emissions outside the flyby

(Beaudonnet, Wurmser, internship 2015)
1- Catalog of Jovian emissions outside the flyby

- Earth flyby
- Jupiter flyby
- Saturn SOI

Flyby period excluded from the catalog

6-month variation of Jupiter radio activity: physical

Detections rise again as the S/C-planet distance decreases
1- Catalog of Jovian emissions outside the flyby
1- Catalog of Jovian emissions **outside** the flyby

Io phase-CML diagram

Mainly Io-C

Mainly Io-D
1- Catalog of Jovian emissions **outside** the flyby

Continuous RPWS observations make it an excellent tracker of Io emissions:

=> (very) long-term monitoring of the Io-Jupiter interaction

=> short-term monitoring as well (< 1 rot.)

Example:

![Graph showing Raw Power Spectral Density (V^2/Hz) measured on Ex antenna (daily-background subtracted)](image-url)
Raw Power Spectral Density (V^2/Hz) measured on Ex antenna (daily-background subtracted)

Io-D

Io-C

Click to center plot on day 2002302-06h

Click to center plot on day 2002303-12h
1- Catalog of Jovian emissions outside the flyby

2016-2017: Cassini/RPWS will likely see Jupiter HOM-DAM simultaneously to Juno/Waves => multi-point + polarization measurements
2- Search for planet-satellites interactions during the flyby

High sensitivity + continuous observations
2- Search for planet-satellites interactions **during** the flyby

**Method (a)**: power time series

- Time interval: 2000-2001
- Southern and Northern power time series (separated by circular polarization)
- Normalized to 1 AU
2- Search for planet-satellites interactions during the flyby

Method (a) : power time series

Io :
- $f = [5-16\text{MHz}]$
- A, B, C and D components all seen
- intensity (instead of occurrence) plot $\Rightarrow$ intensity reference
2- Search for planet-satellites interactions during the flyby

Method (a): power time series

Ganymede:
- $f = [5-16\text{MHz}]$
- Ganymede C emission?
2- Search for planet-satellites interactions during the flyby

Method (a) : power time series

Europa :
- \( f = [1-16\text{MHz}] \)
- Europa D emission ?
2- Search for planet-satellites interactions during the flyby

Method (b) : simulations of dynamic spectra

- CMI-based visibility modeling with the ExPRES code (Hess et al., 08,11,16; Lamy et al.,08b,13)

- updated magnetic field model : ISaAC (>VIPAL) constrained by the locus of both Io and Ganymede UV footprints (Hess, pers. com.)

=> long-term simulations of Io, Europa & Ganymede
2- Search for planet-satellites interactions during the flyby

Method (b): simulations of dynamic spectra

Flux density @ 1AU (Log W.m$^{-2}$ Hz$^{-1}$)

Circular polarization

North
South
2- Search for planet-satellites interactions during the flyby

Method (b) : simulations of dynamic spectra
2- Search for planet-satellites interactions during the flyby

Method (b) : simulations of dynamic spectra

Flux density @ 1AU (Log W.m\(^{-2}\).Hz\(^{-1}\))

Circular polarization

North
South
2- Search for planet-satellites interactions during the flyby

Method (b) : simulations of dynamic spectra

Flux density @ 1AU (Log W.m\(^{-2}\).Hz\(^{-1}\))

Circular polarization

Io-D
2- Search for planet-satellites interactions during the flyby

Method (b) : simulations of dynamic spectra

Flux density @ 1AU (Log W.m$^{-2}$.Hz$^{-1}$)

Circular polarization

Ga-D !
2- Search for planet-satellites interactions during the flyby

Method (b) : simulations of dynamic spectra

Flux density @ 1AU (Log W.m⁻².Hz⁻¹)

Circular polarization
2- Search for planet-satellites interactions during the flyby

Method (b) : simulations of dynamic spectra

Flux density @ 1AU (Log W.m$^{-2}$.Hz$^{-1}$)

Circular polarization

DOY 2001-030 (h)

Io-C Eu-C !
2- Search for planet-satellites interactions during the flyby

Method (b) : simulations of dynamic spectra

(Louis et al., in prep.) :

- Catalog of Europa and Ganymede detections
  
  + Cassini/RPWS : 2000-2003
    177 candidates total : 105 Europa + 69 Ganymede + 3 Europa or Ganymede
  
  + Voyager/PRA : 1979
    Voyager 1 => 15 candidates total : 10 Europa + 5 Ganymede
    Voyager 2 => 24 candidates total : 12 Europa + 12 Ganymede
    NB : One case where Europa was observed by both spacecraft

- Search for multi-point measurements (Nançay decameter array).

- Characterization of average properties in progress : occurrence, spectrum, arc shape, multiplicity, intensity, variability etc.
Conclusions

* Cassini/RPWS regularly tracked Jupiter emissions over 1999-2005 and >2013
  => unexpected support to Juno ?

* Outside the flyby period : mainly Io
  => Io activity can be tracked on long (years) and short (half a revolution) timescales

* During the flyby :

  (a) Satellite phase-CML diagrams of intensity :
      => all components of Io
      => possible detection of Europa and Ganymede

  (b) Simulations of Europa and Ganymede induced emissions :
      => identification of Europa arcs !
      => identification of Ganymede arcs !
      => statistical study in progress.