

Les chants électriques de l'Univers

Philippe Zarka

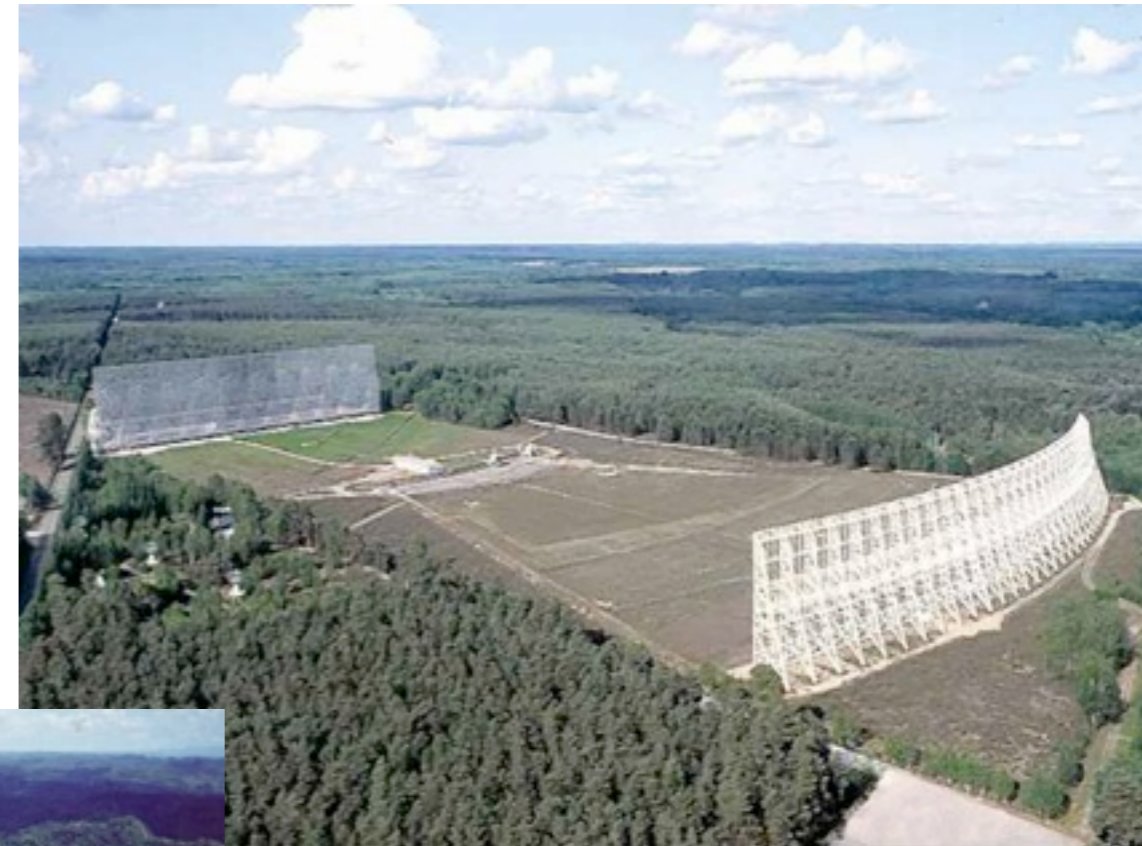
Observatoire de Paris - CNRS (LESIA, Meudon)

Nanterre, 9 mars 2013

On parle souvent de la "musique des sphères",
ou des radiotélescopes comme de "grandes
oreilles à l'écoute du cosmos"



PARKES RADIO TELESCOPE (CSIRO / A



On parle souvent de la "musique des sphères",
ou des radiotélescopes comme de "grandes
oreilles à l'écoute du cosmos"



Or aucun son ne se propage à travers
le vide de l'espace ...



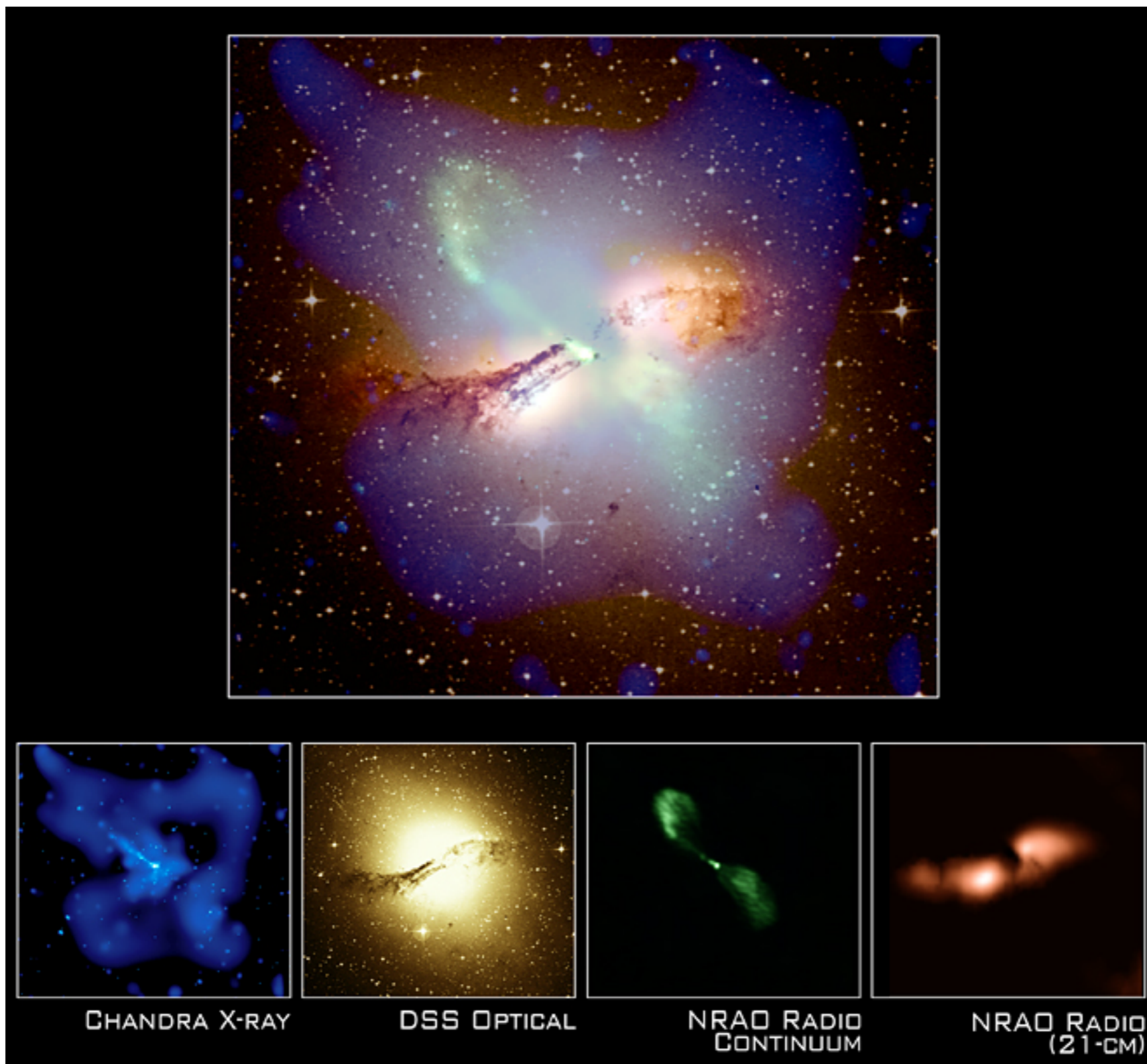
Les astres seraient-ils donc
désespérément muets ?



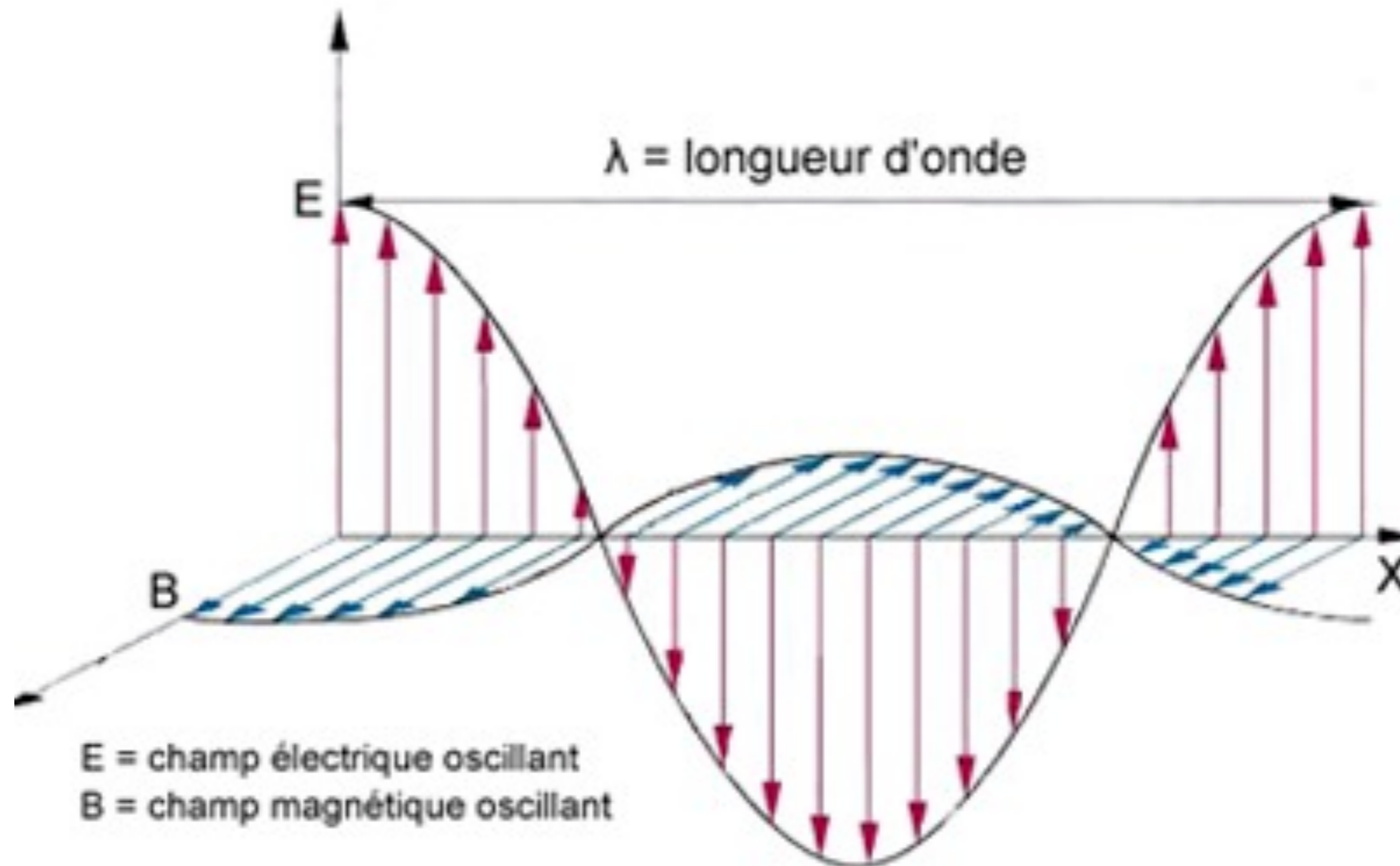
Pas nécessairement: ils nous envoient
de la lumière, visible et invisible.



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de la lumière, visible et invisible.

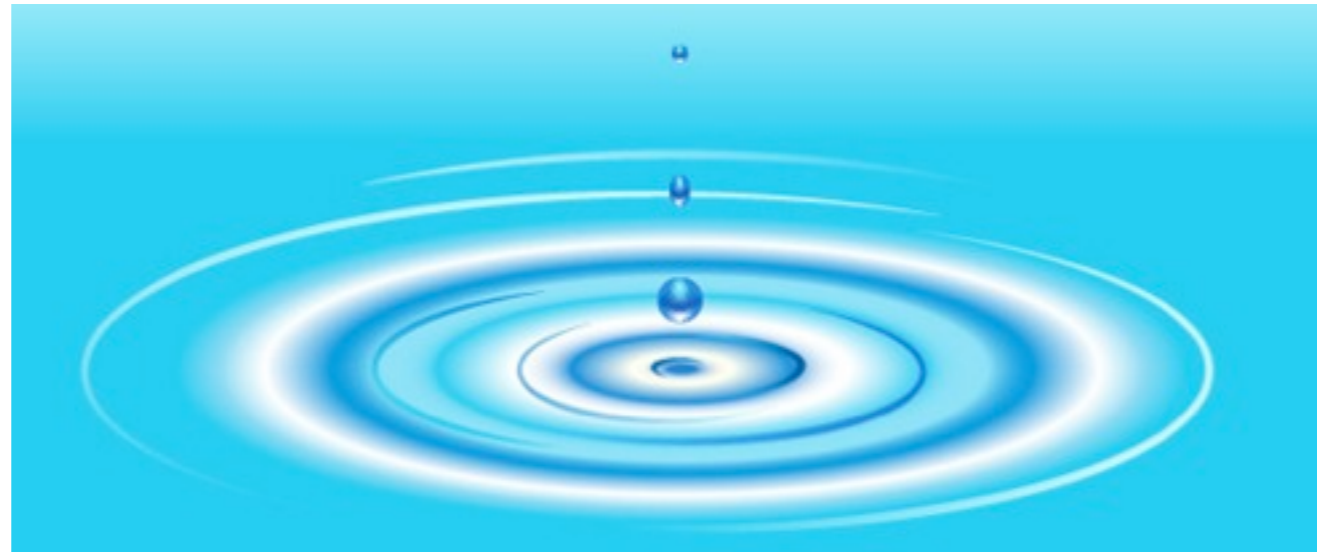


La lumière est une onde ...

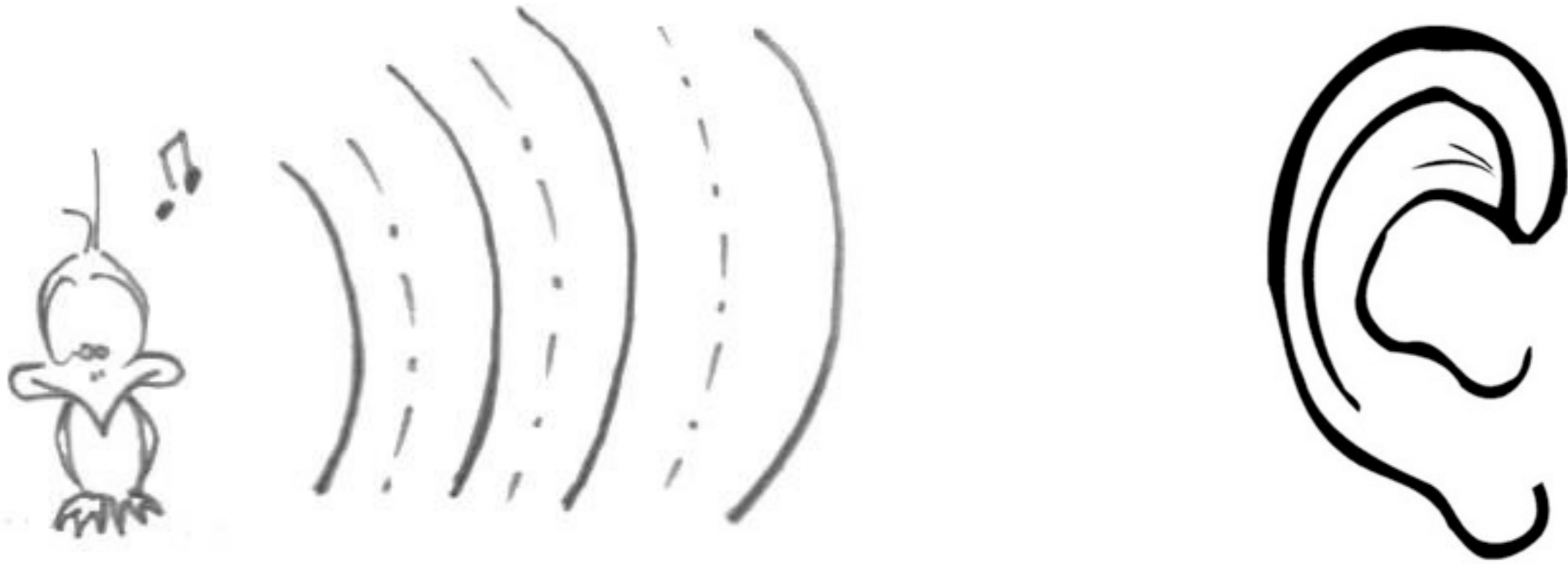


de l'énergie qui se propage de manière "organisée", sous forme d'une ondulation

... comme les rides à la surface de l'eau ...



... comme le son



vibrations de l'air qui se transmettent
de proche en proche par collisions

fréquences audibles

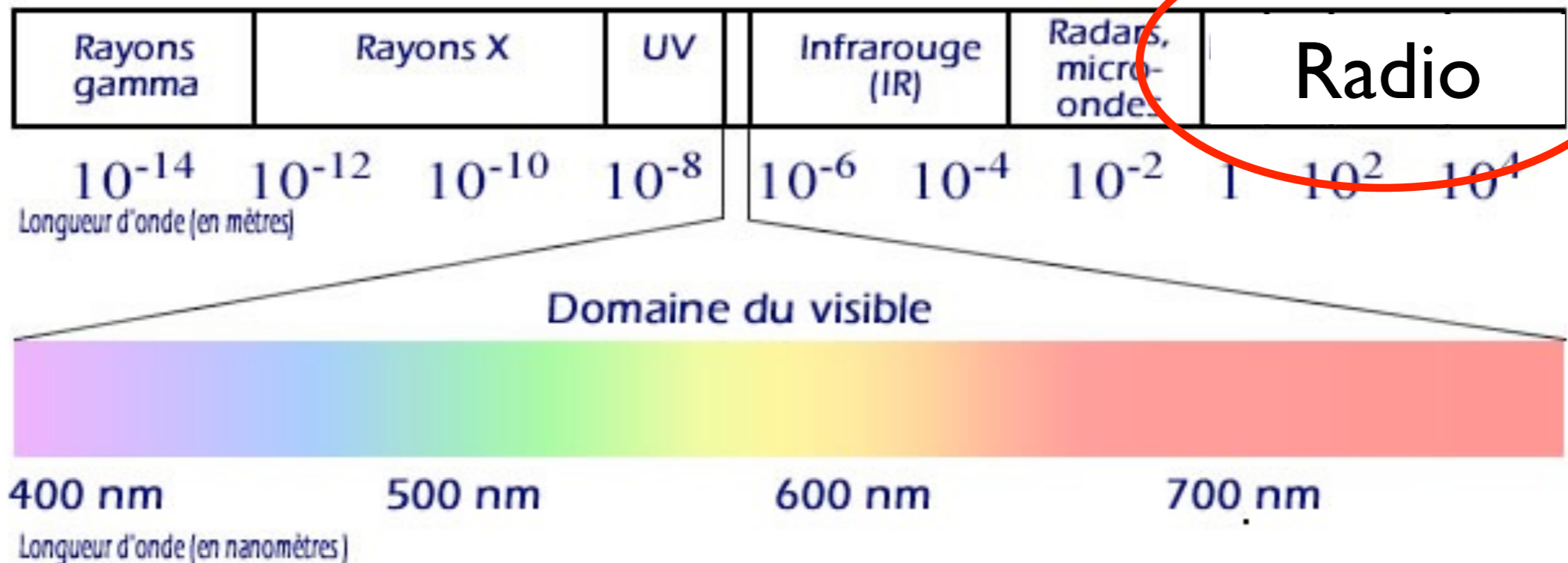
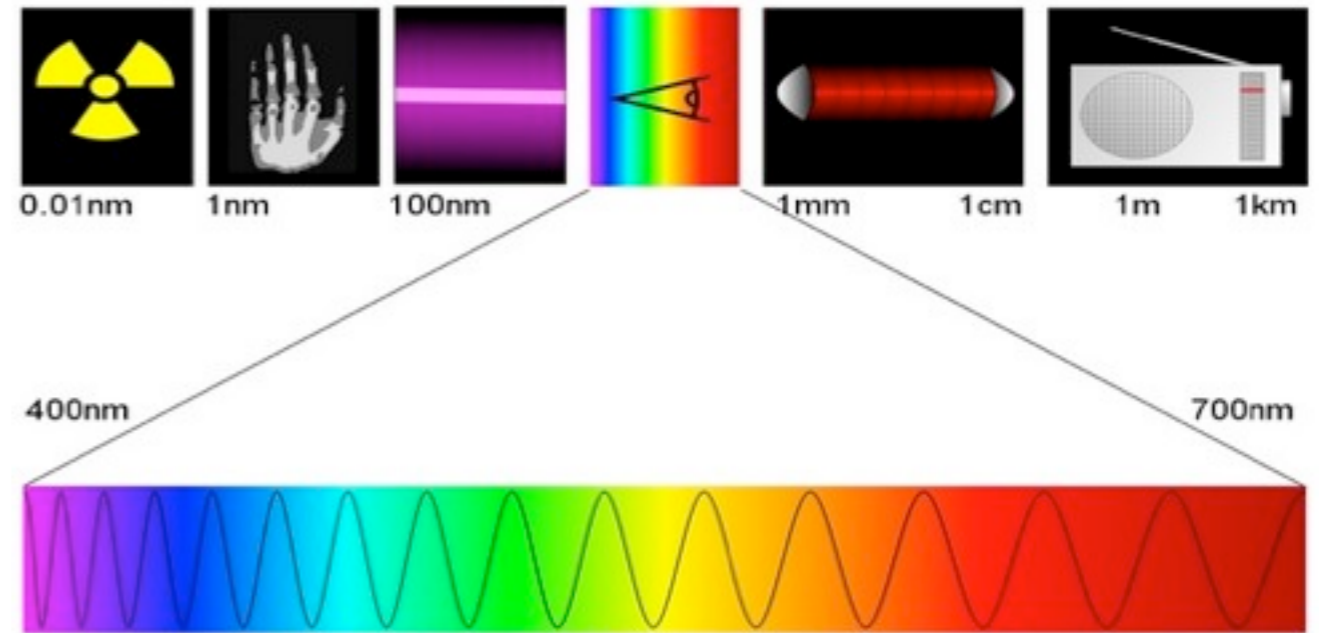
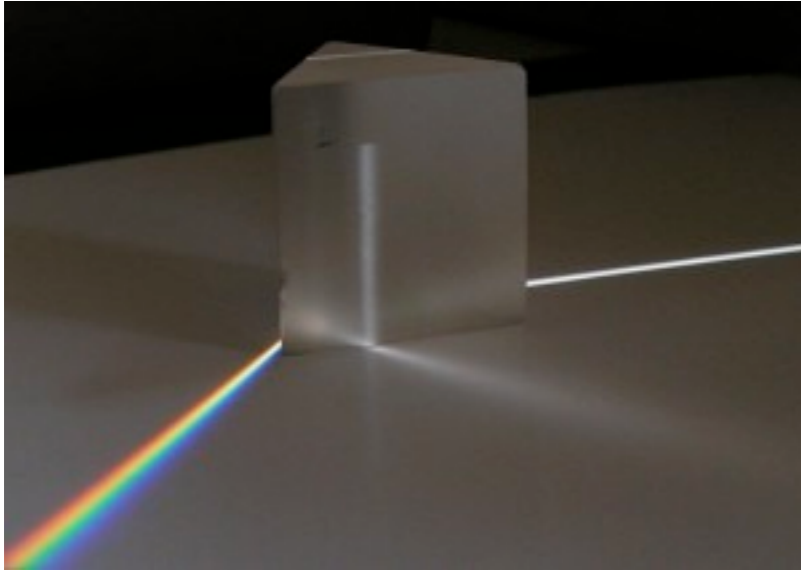


vitesse de propagation du son		
air		340 m/s
eau		1500 m/s
acier		5000 m/s

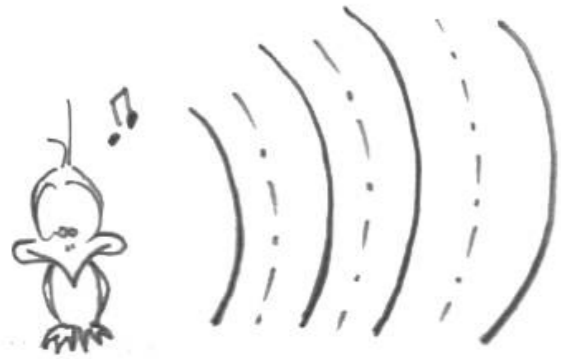
vitesse de propagation de la lumière : 300000 km/s



Ondes lumineuses visibles et invisibles, ondes radio



La radiodiffusion

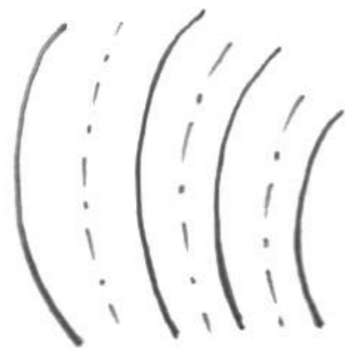
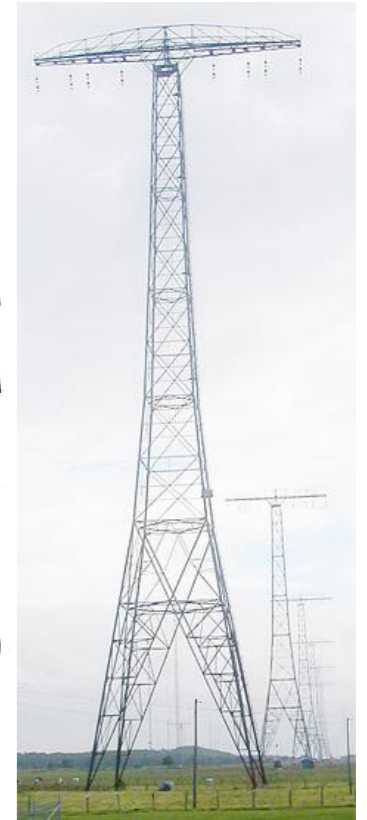
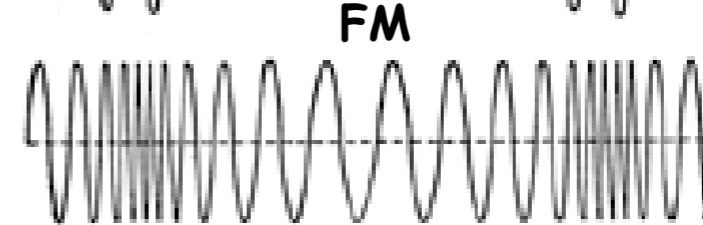
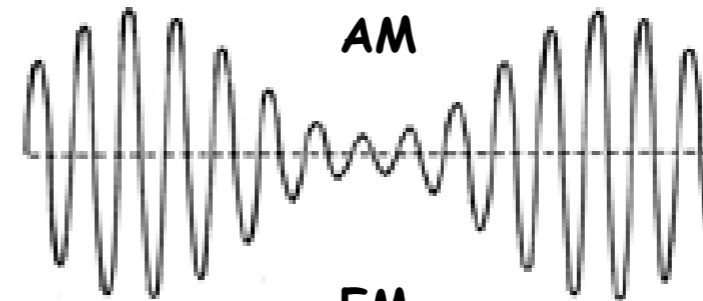
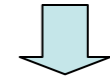
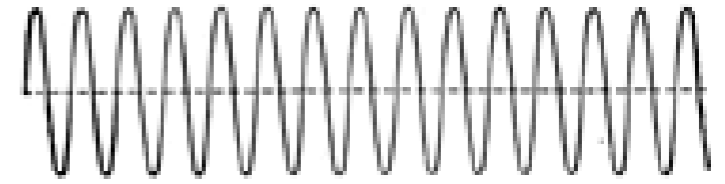


Tchip, tchip



X

Onde radio « porteuse »



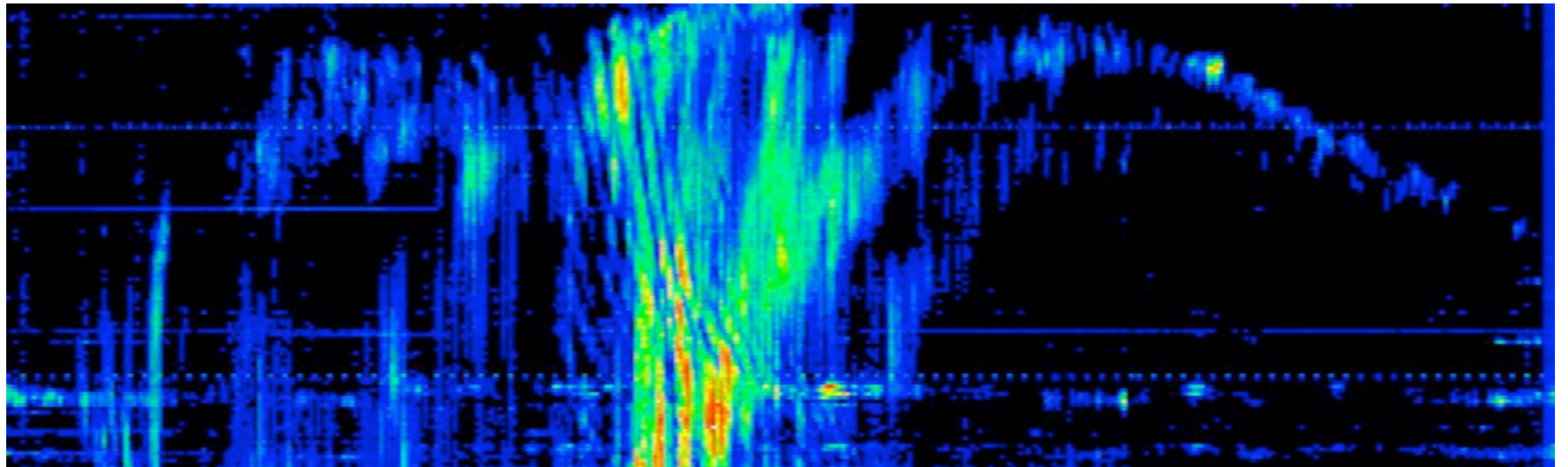
Tchip, tchip



Les ondes radio en images : le spectre dynamique

(une image temps-fréquence-intensité)

fréquence

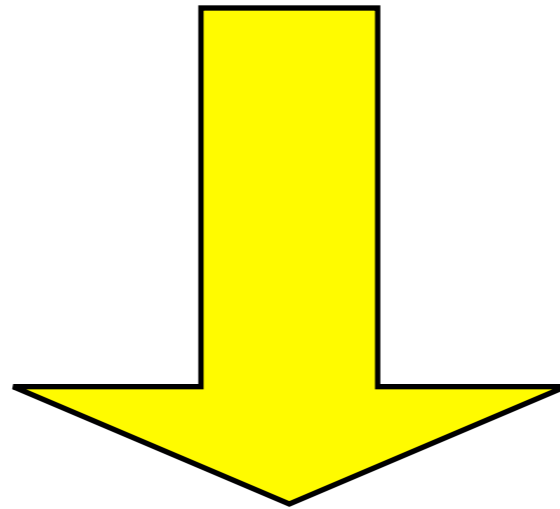


temps

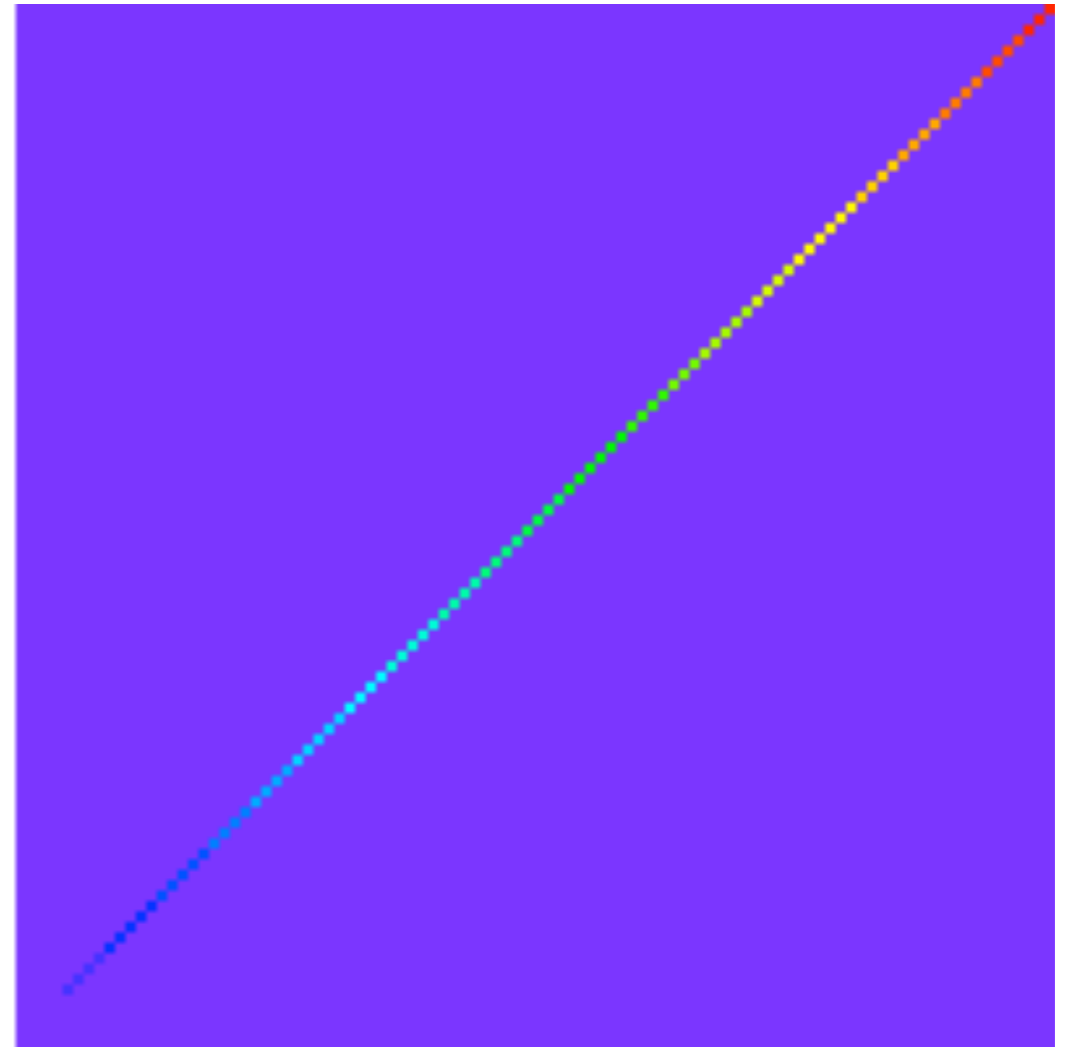
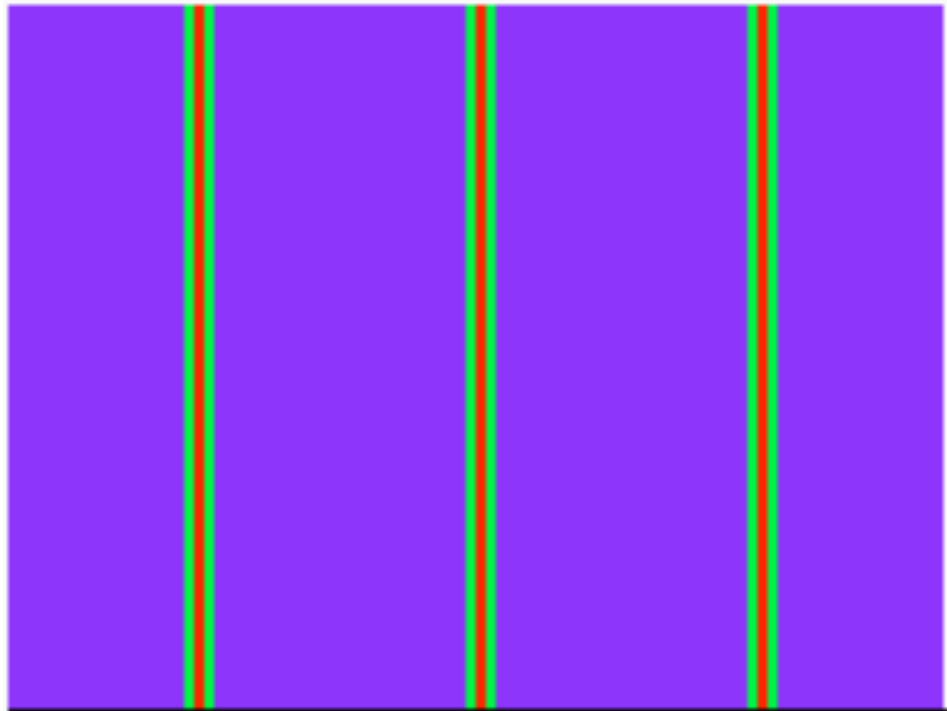
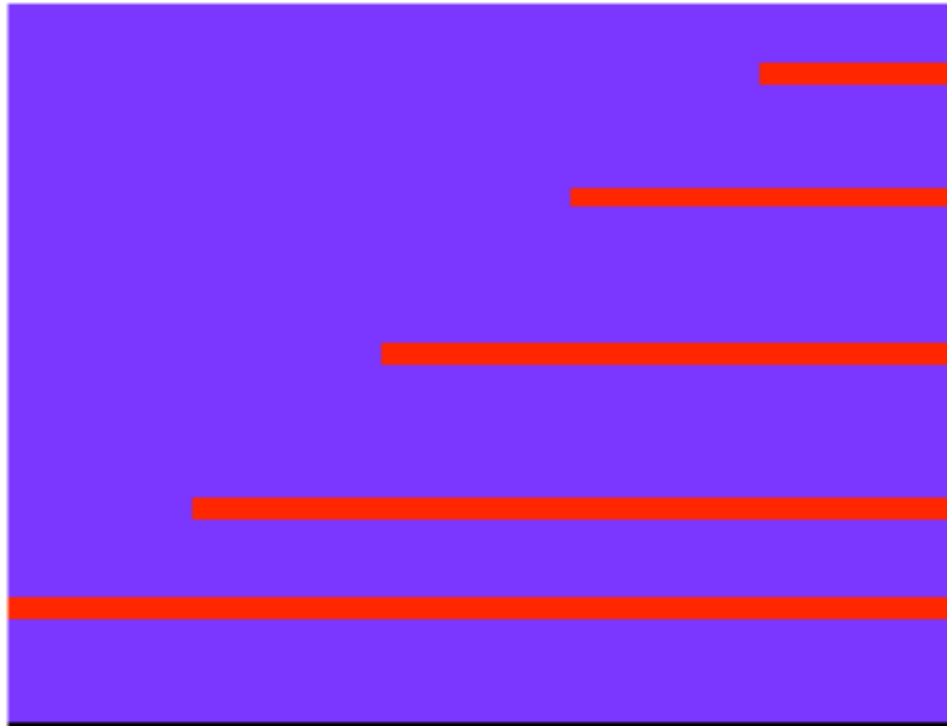
Les sons en images : le sonogramme

(une image temps-fréquence-intensité)

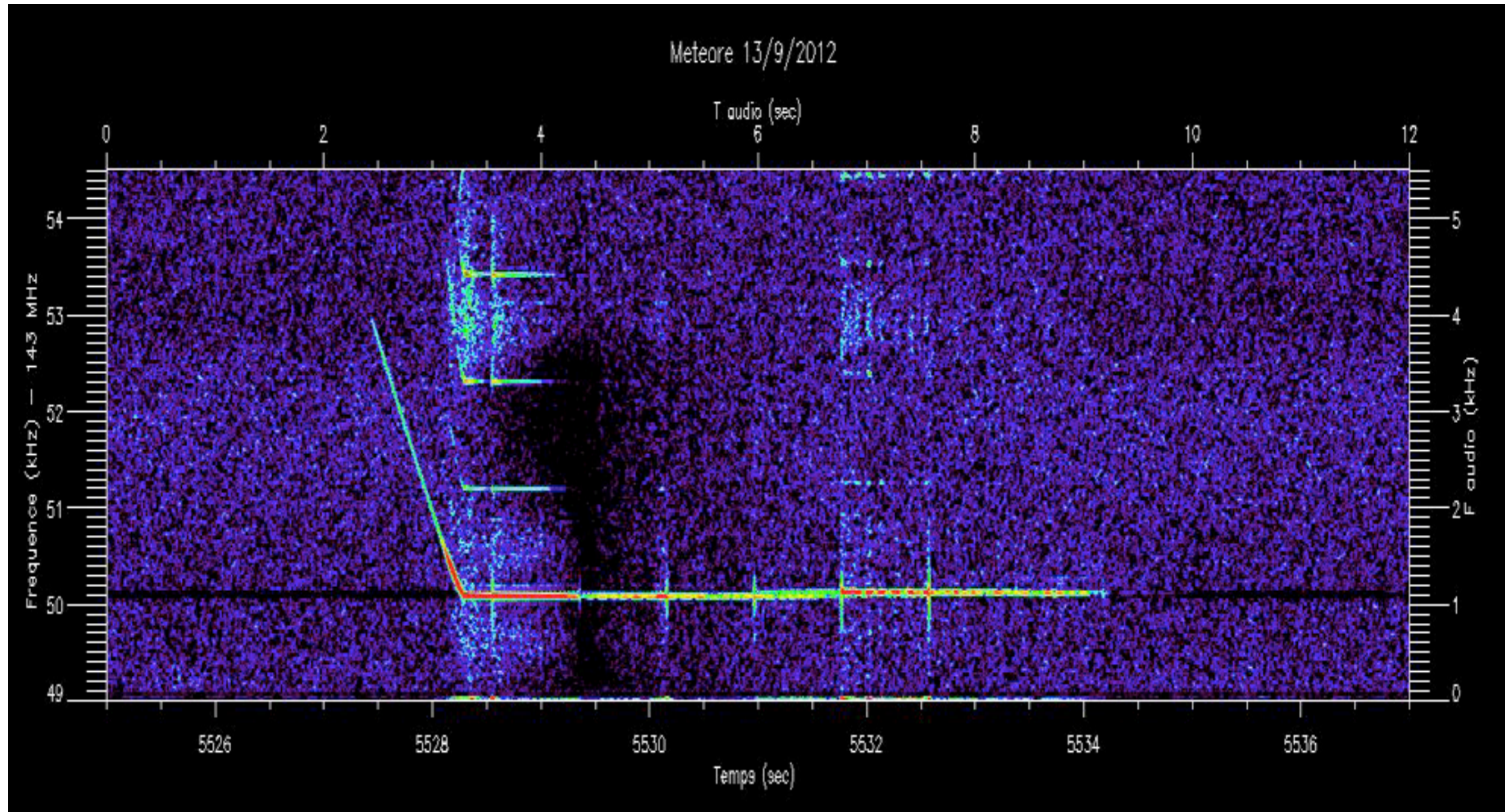
Démo iSpectrum



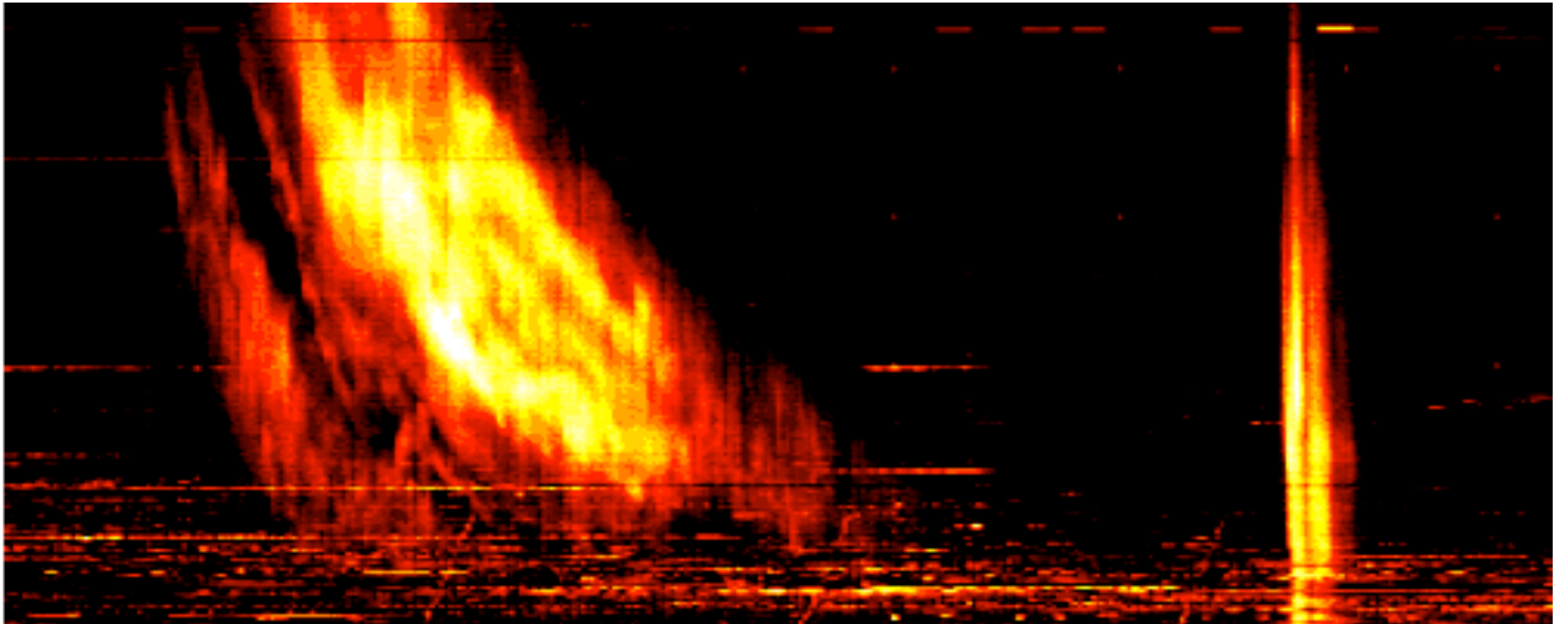
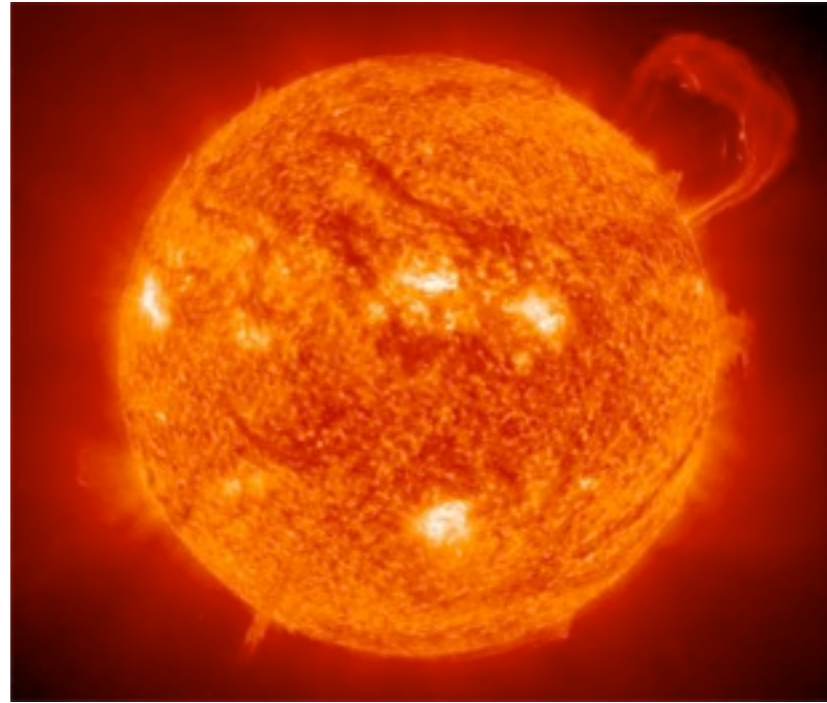
Les ondes radio en sons



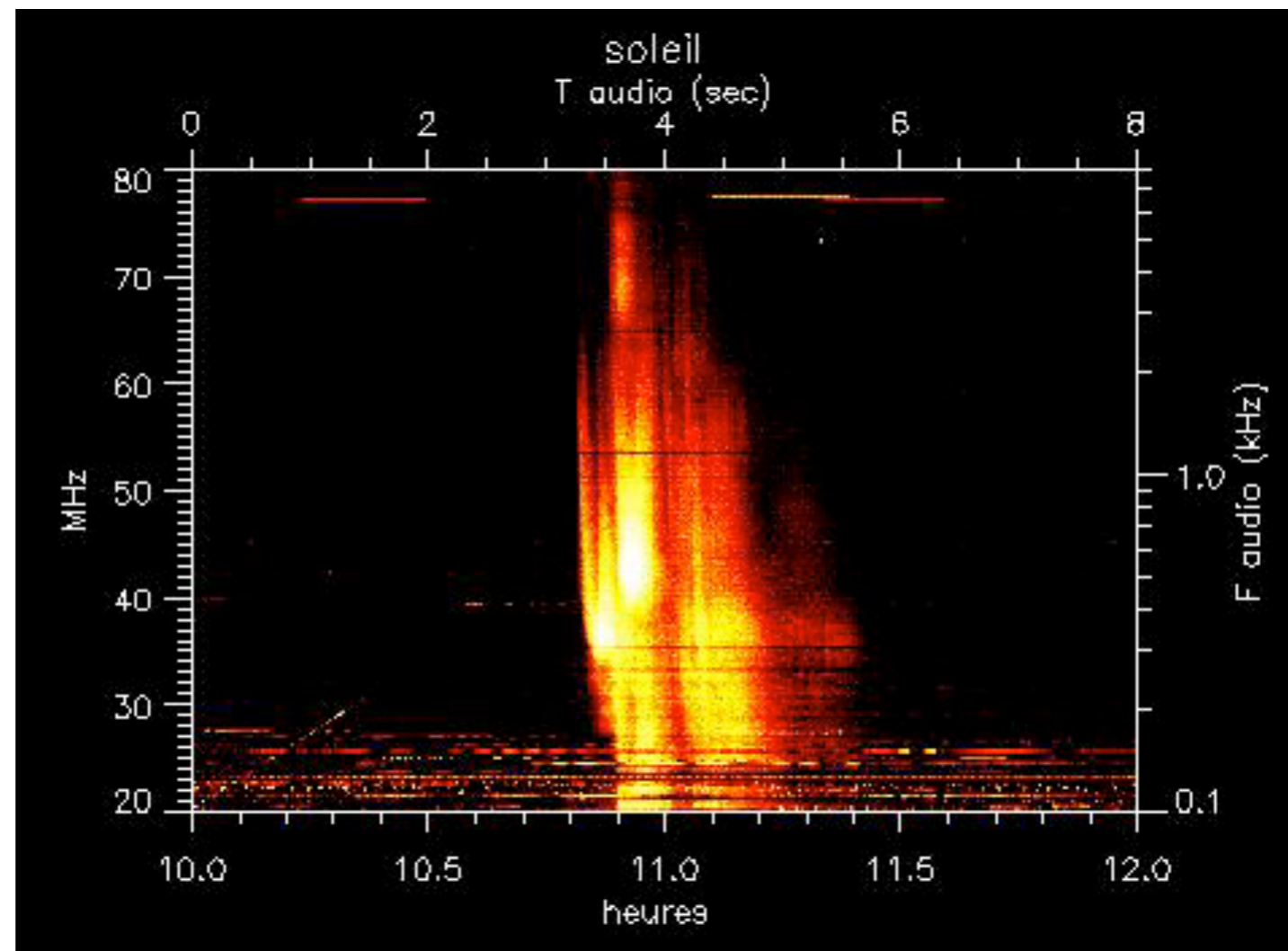
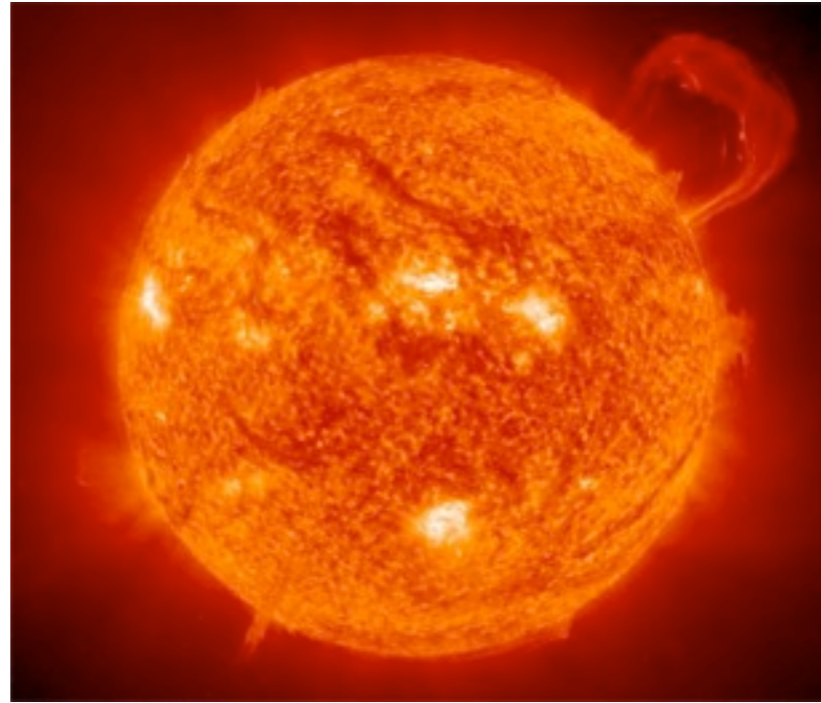
Un météore dans l'atmosphère ...



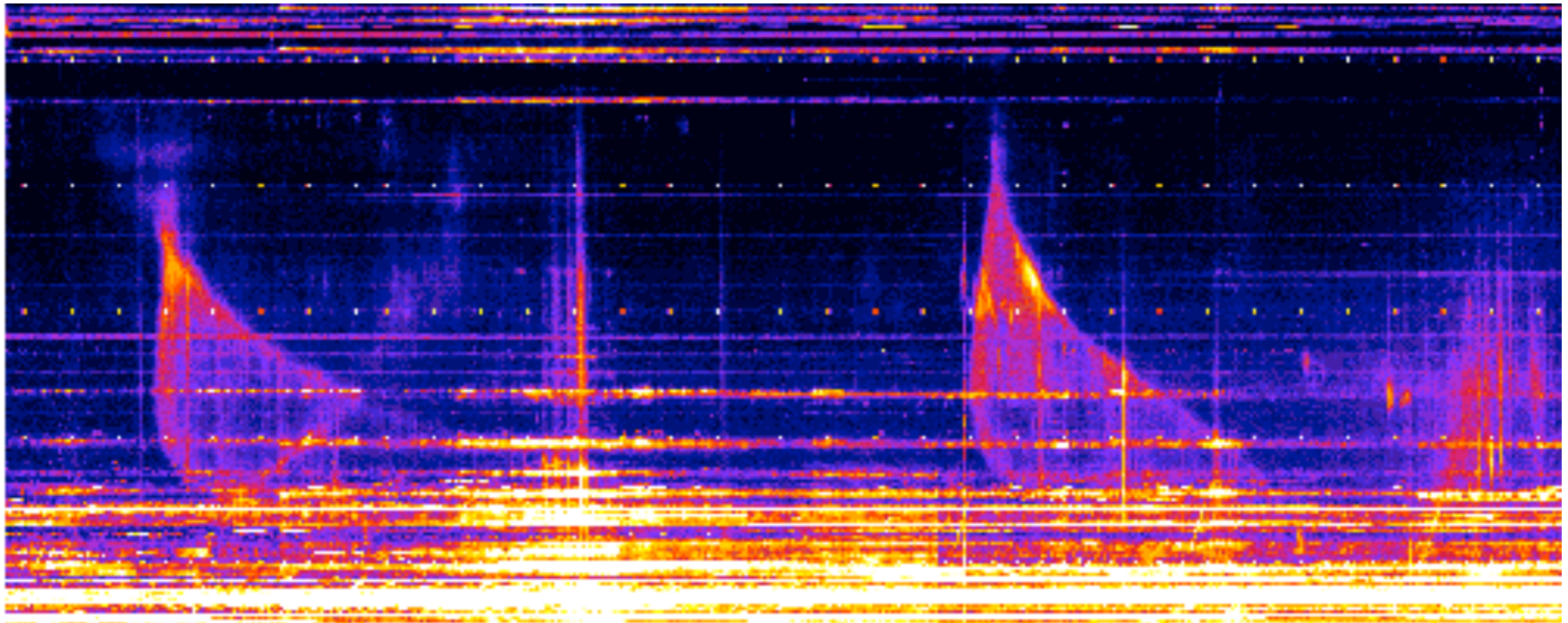
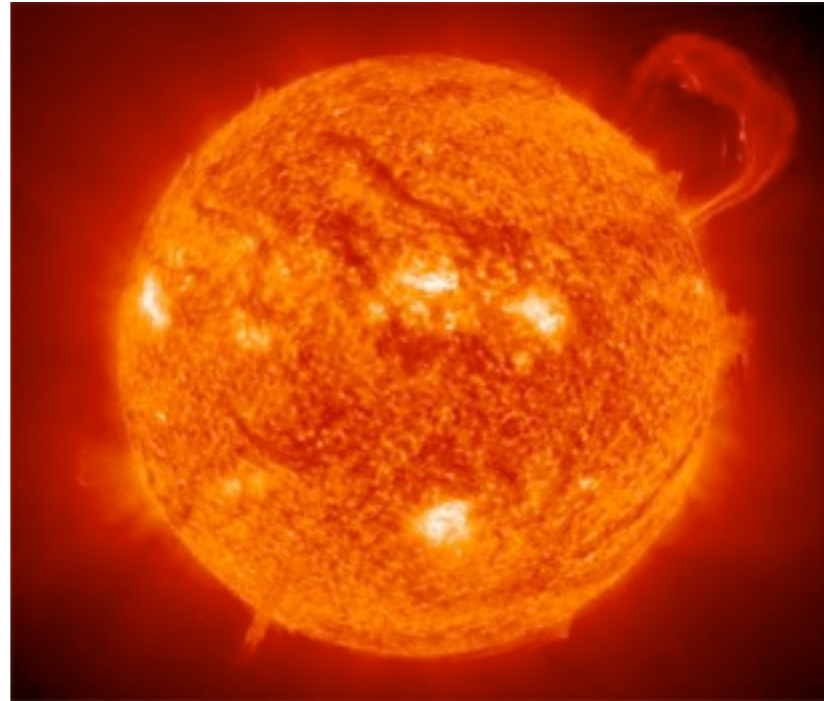
Le Soleil : 8 minutes-lumière



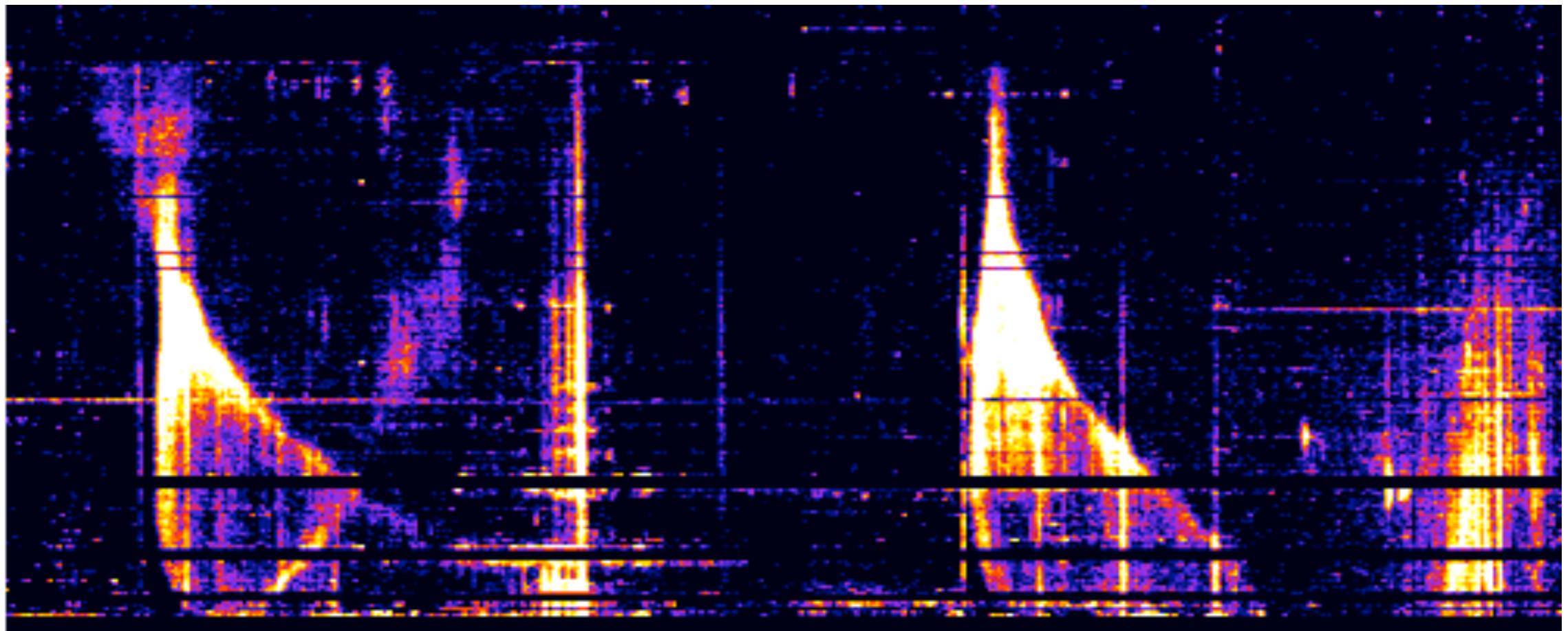
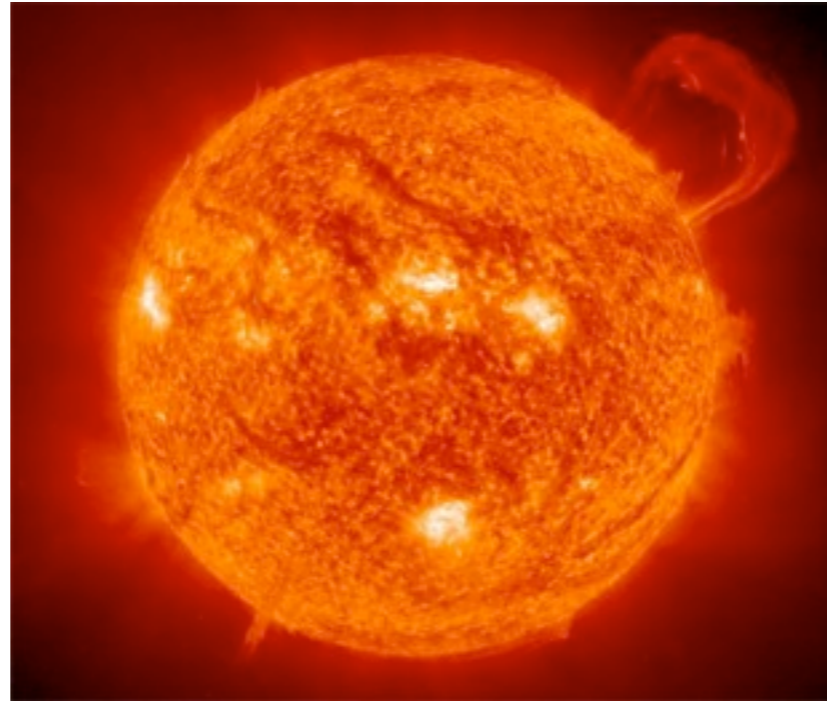
Le Soleil : 8 minutes-lumière



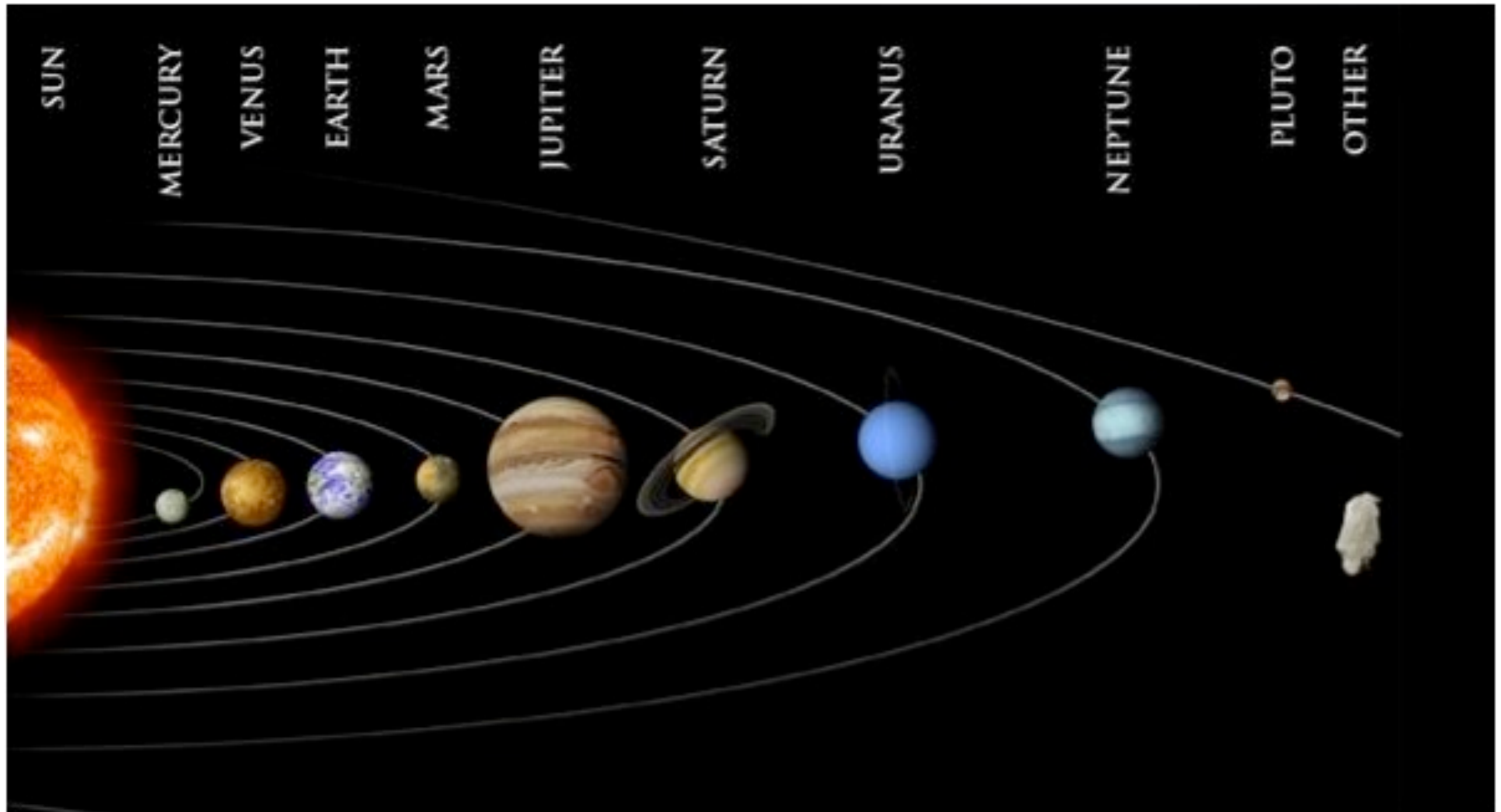
Le Soleil : 8 minutes-lumière



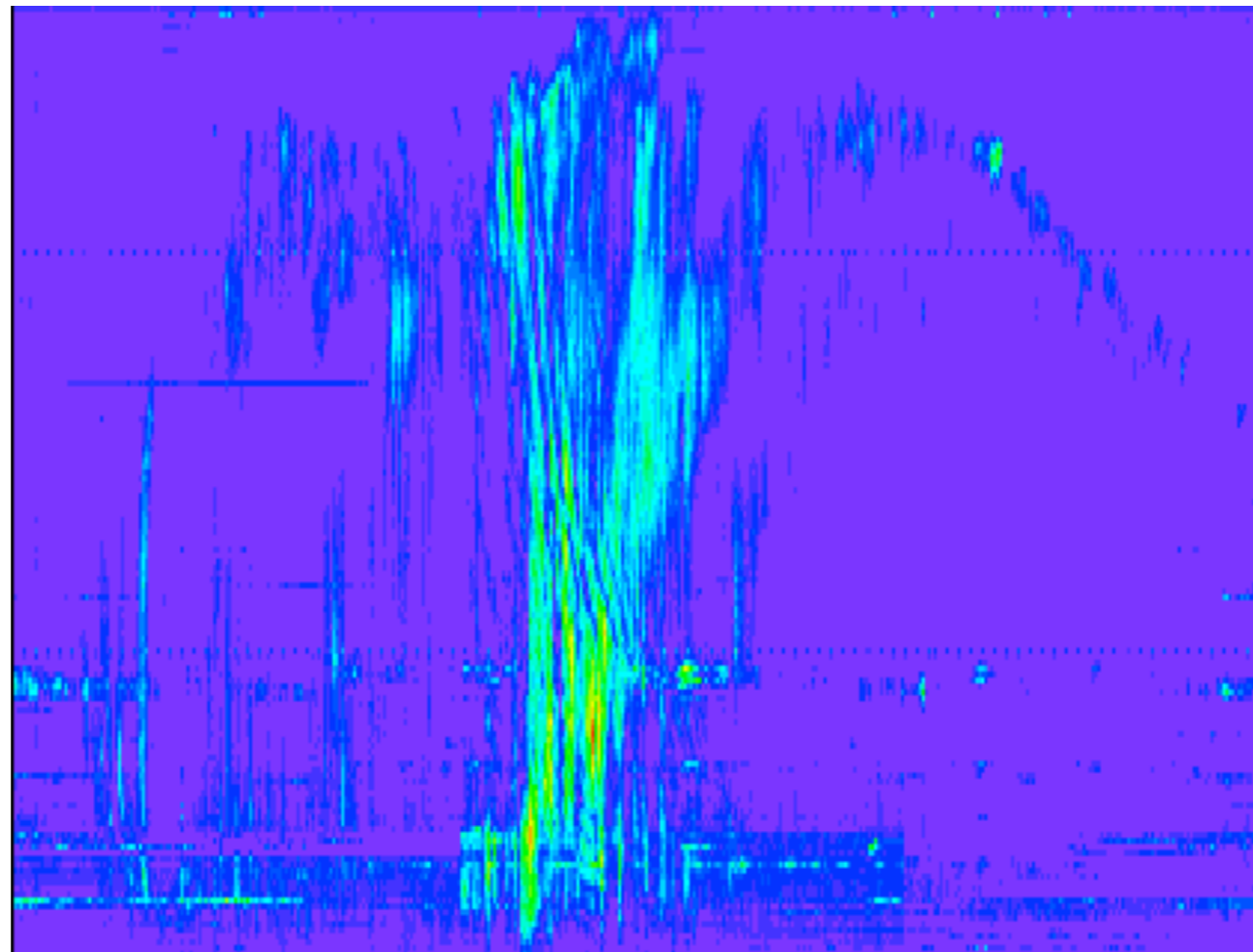
Le Soleil : 8 minutes-lumière



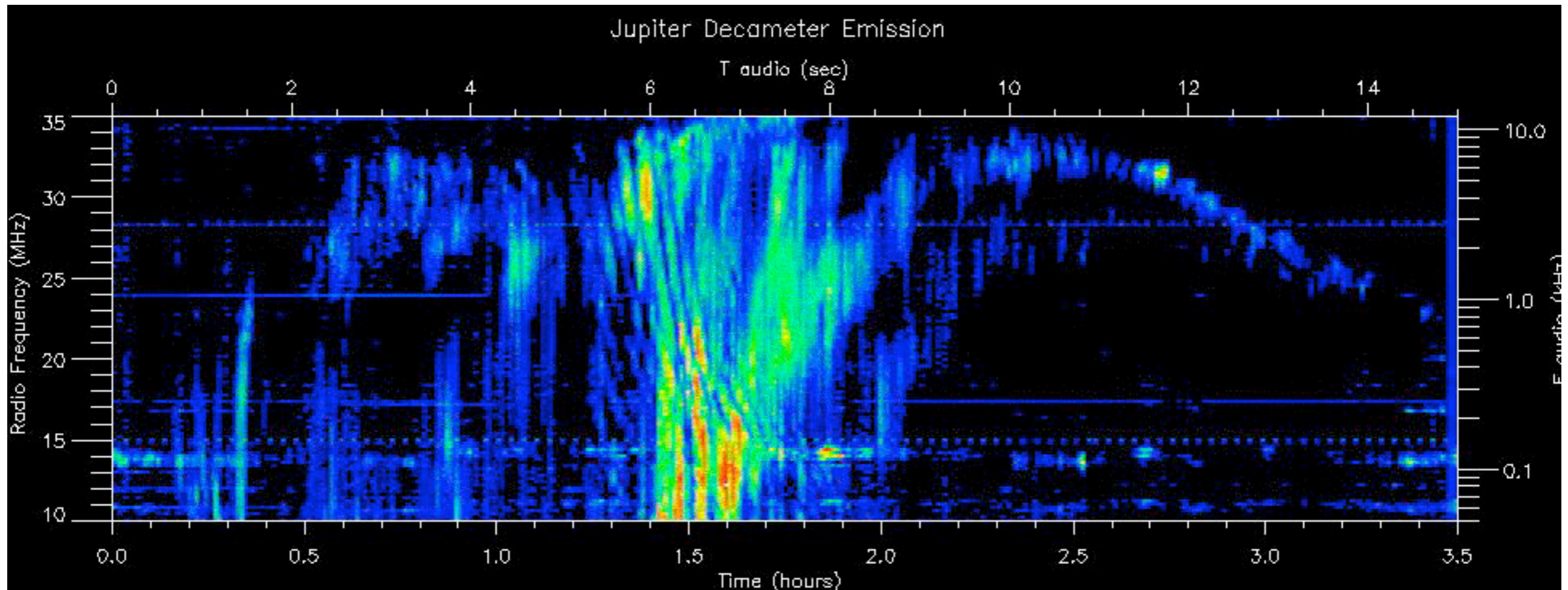
Le système solaire



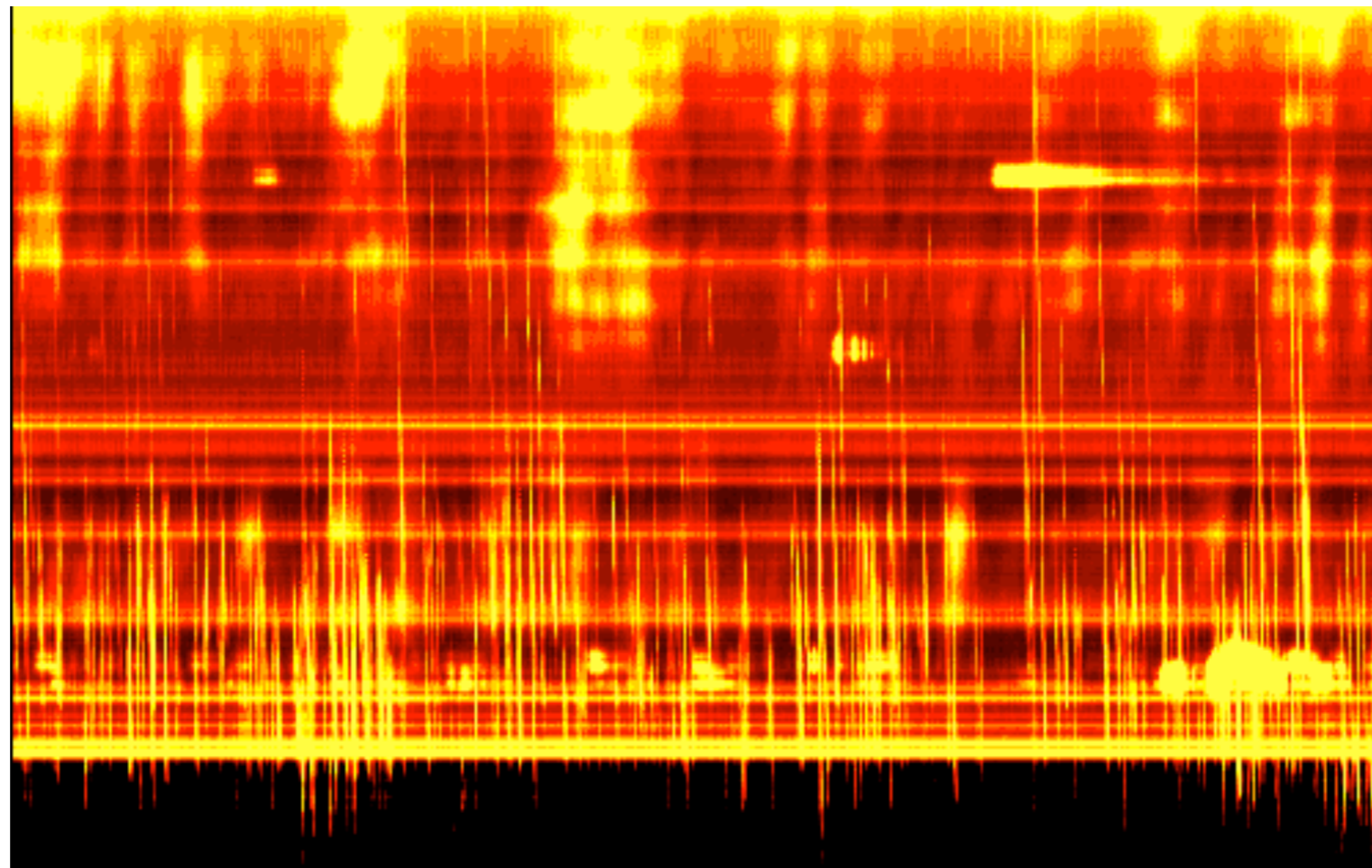
Jupiter : 40 minutes-lumière



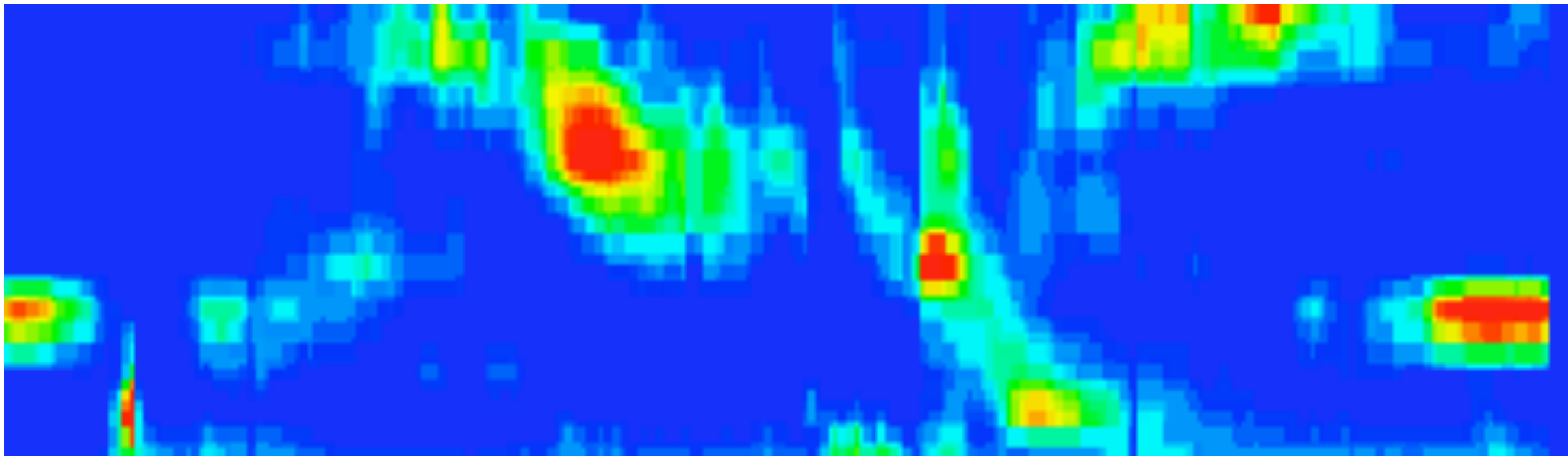
Jupiter : 40 minutes-lumière



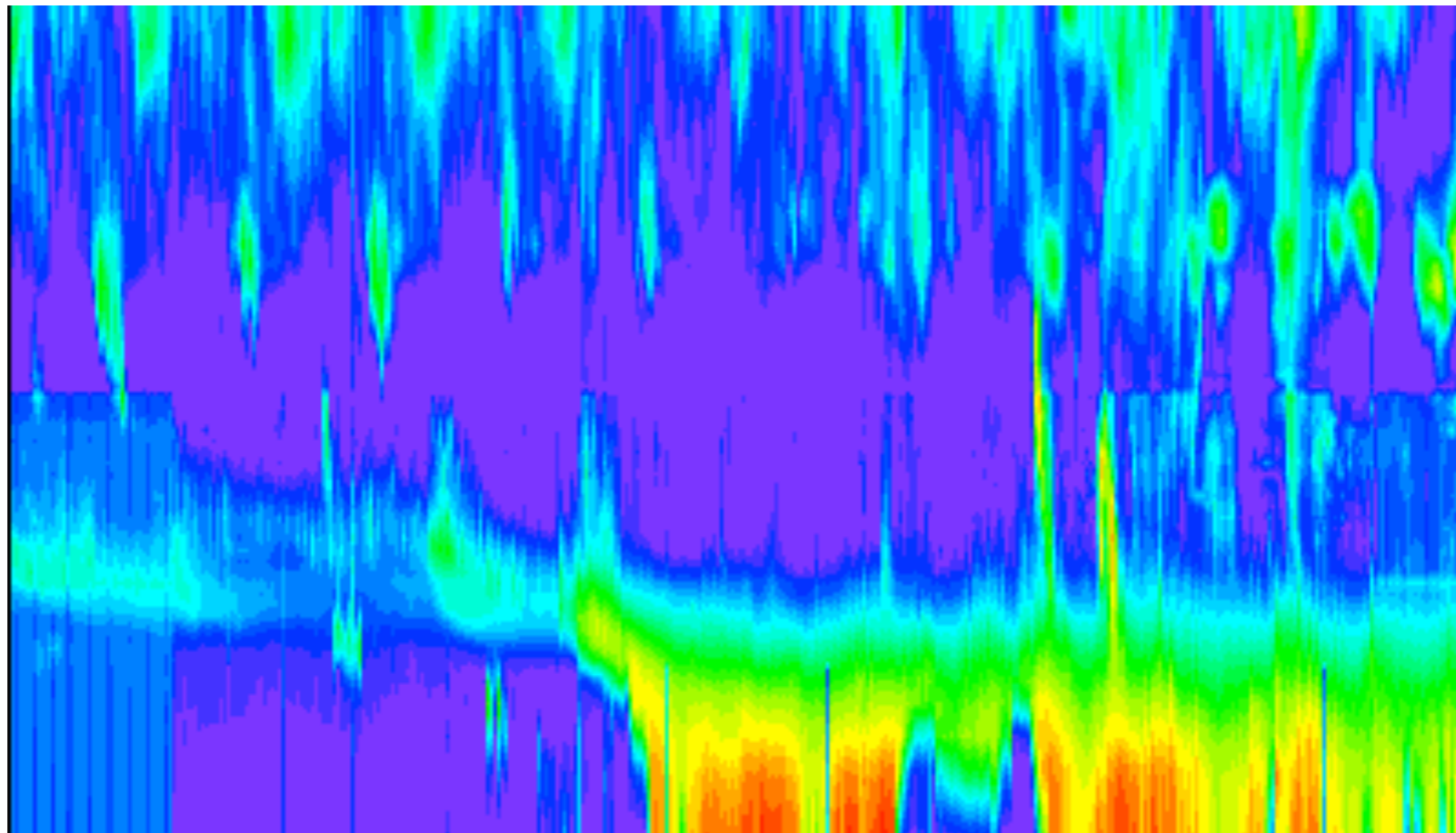
Jupiter : 40 minutes-lumière



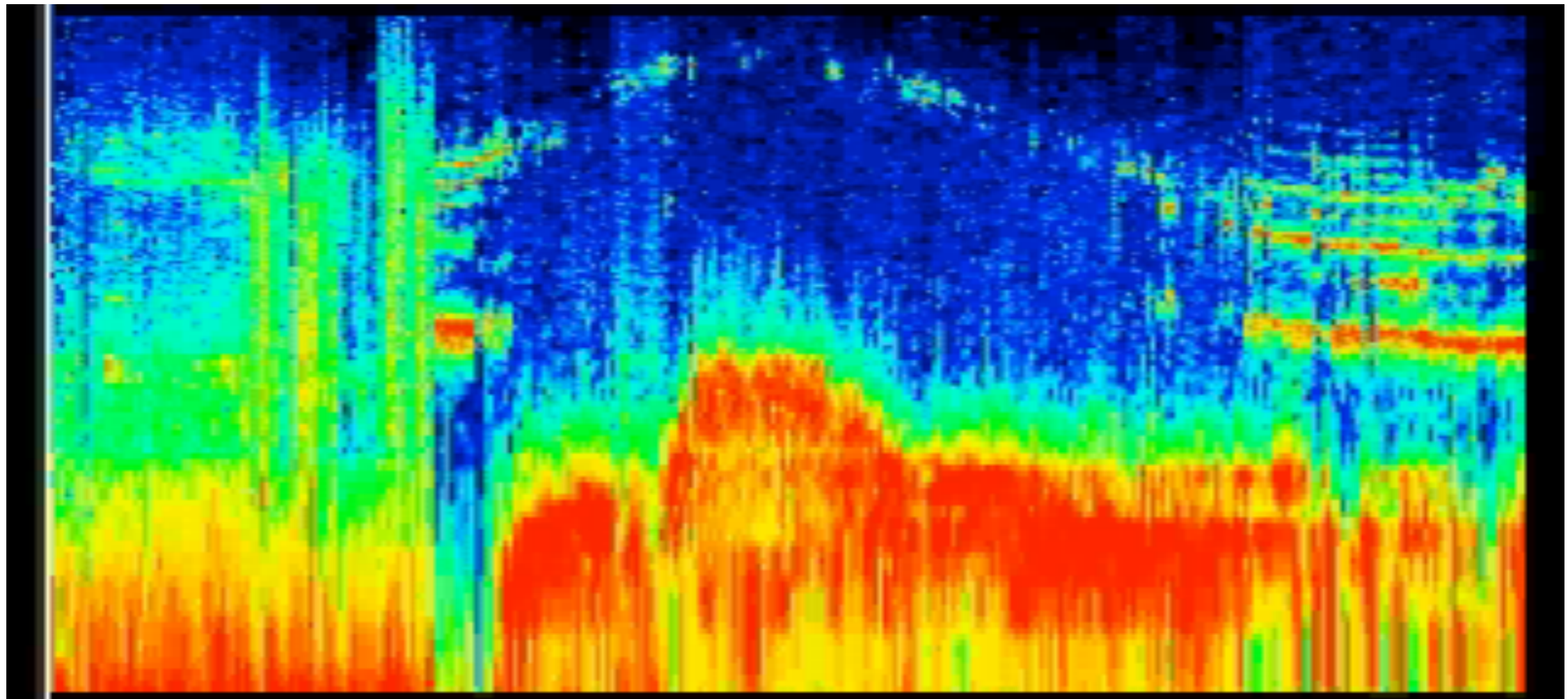
Jupiter : 40 minutes-lumière



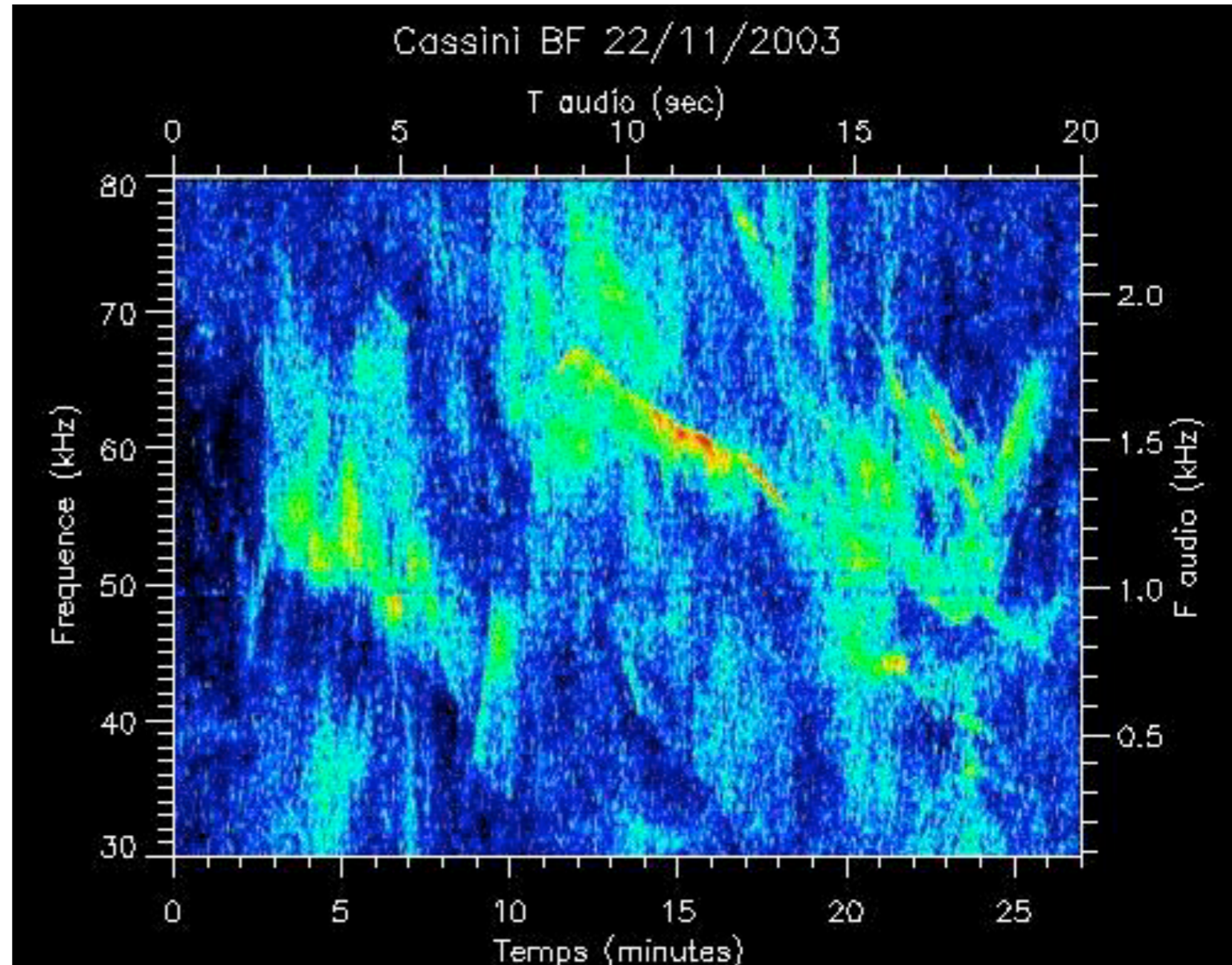
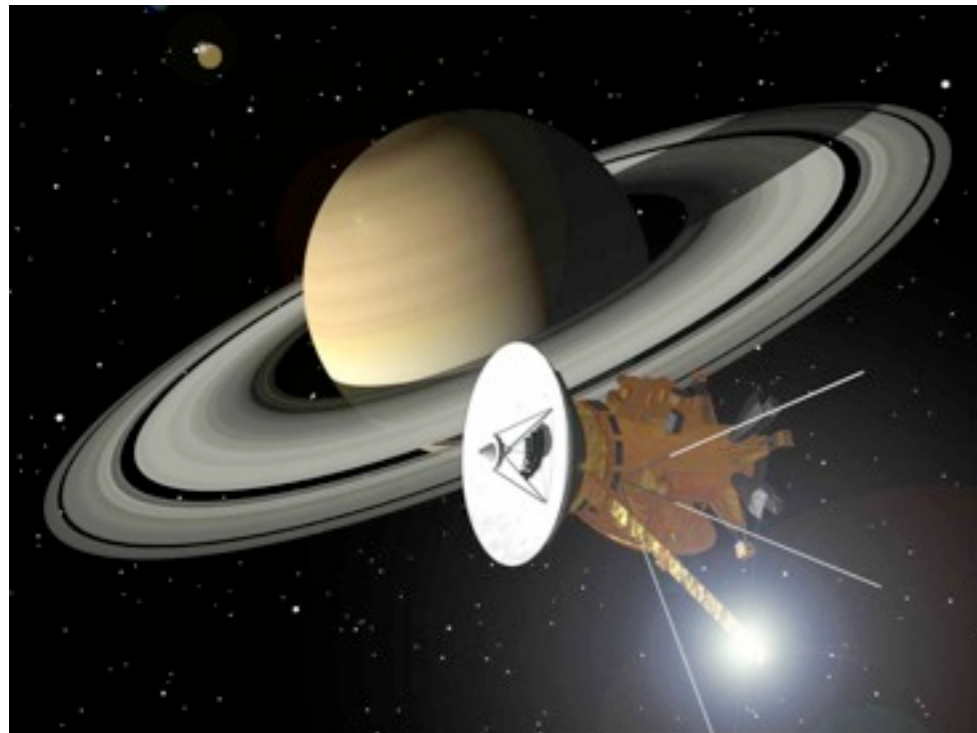
Jupiter : 40 minutes-lumière



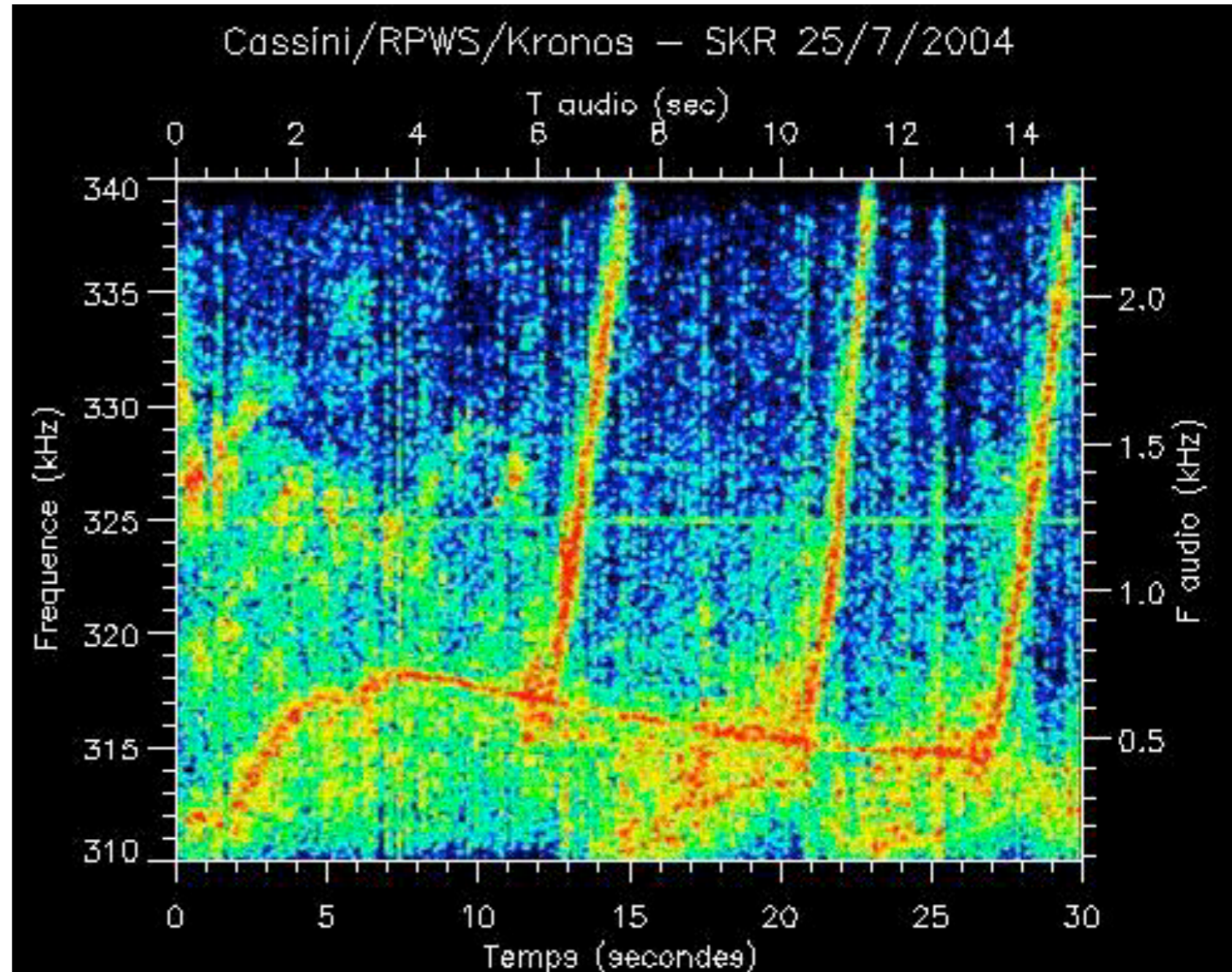
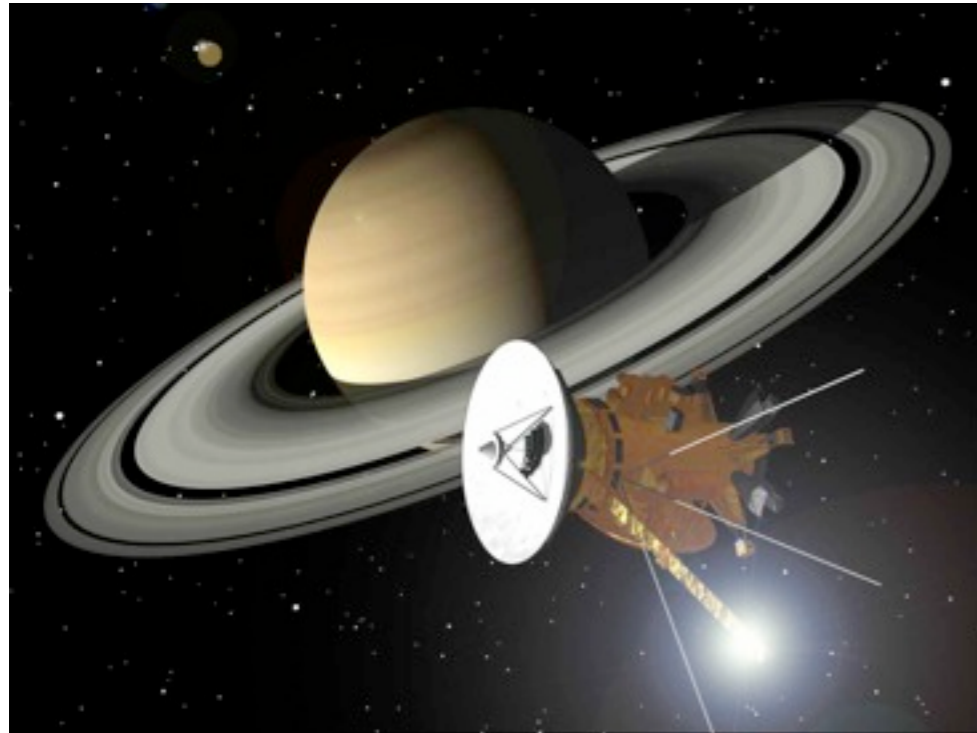
Jupiter : 40 minutes-lumière



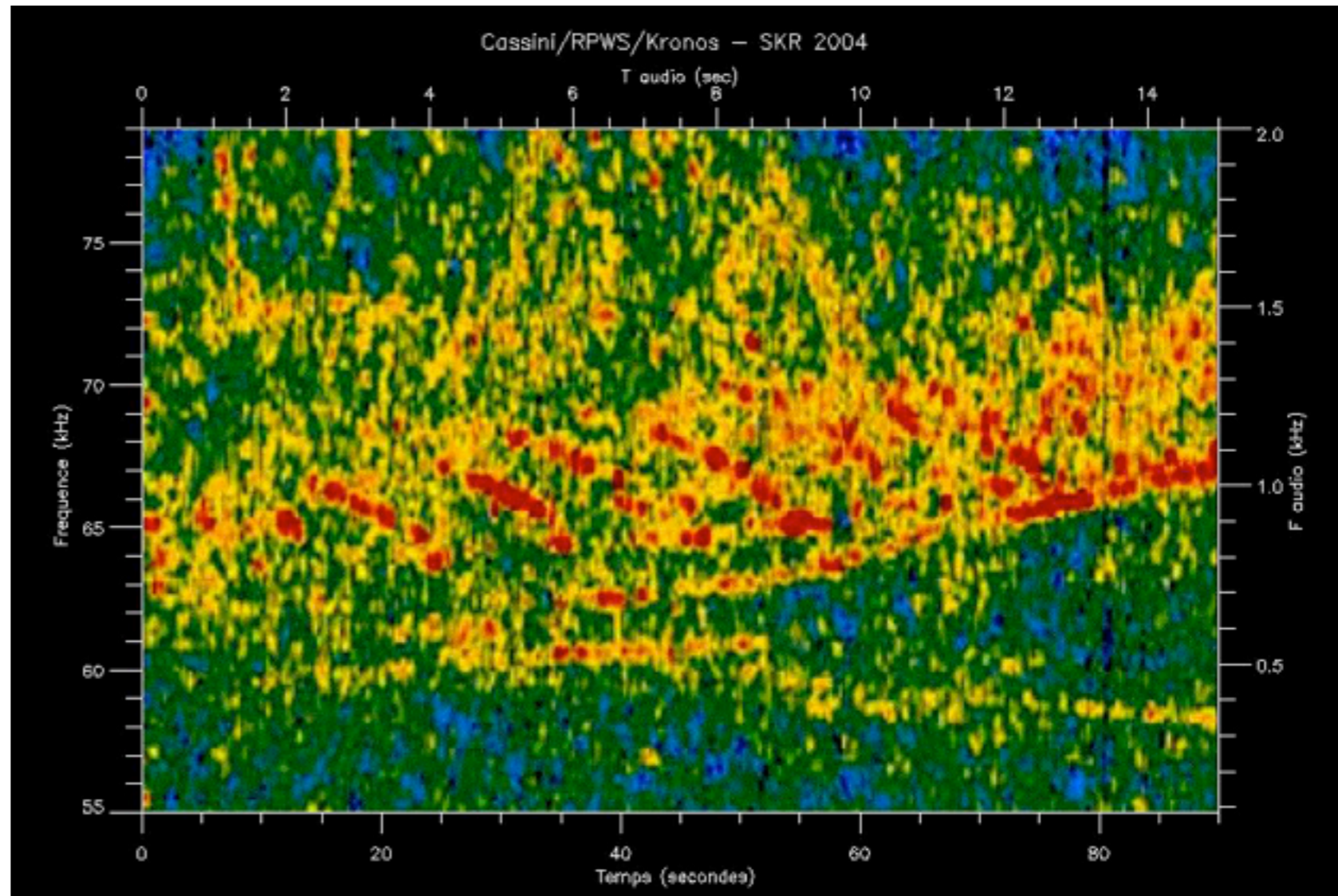
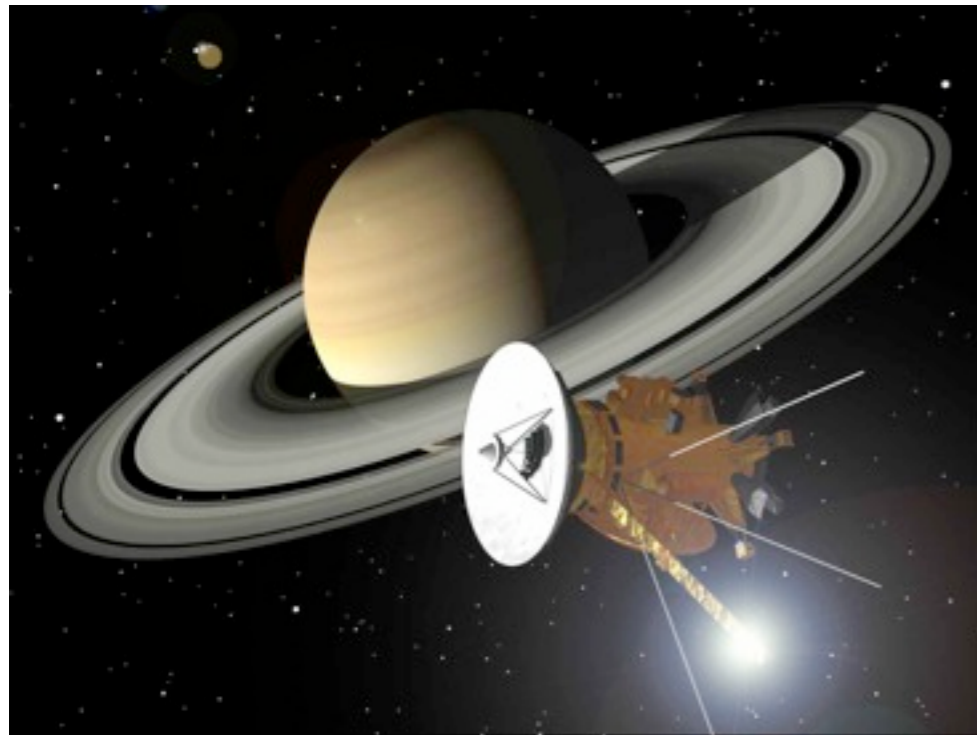
Saturne : 80 minutes-lumière



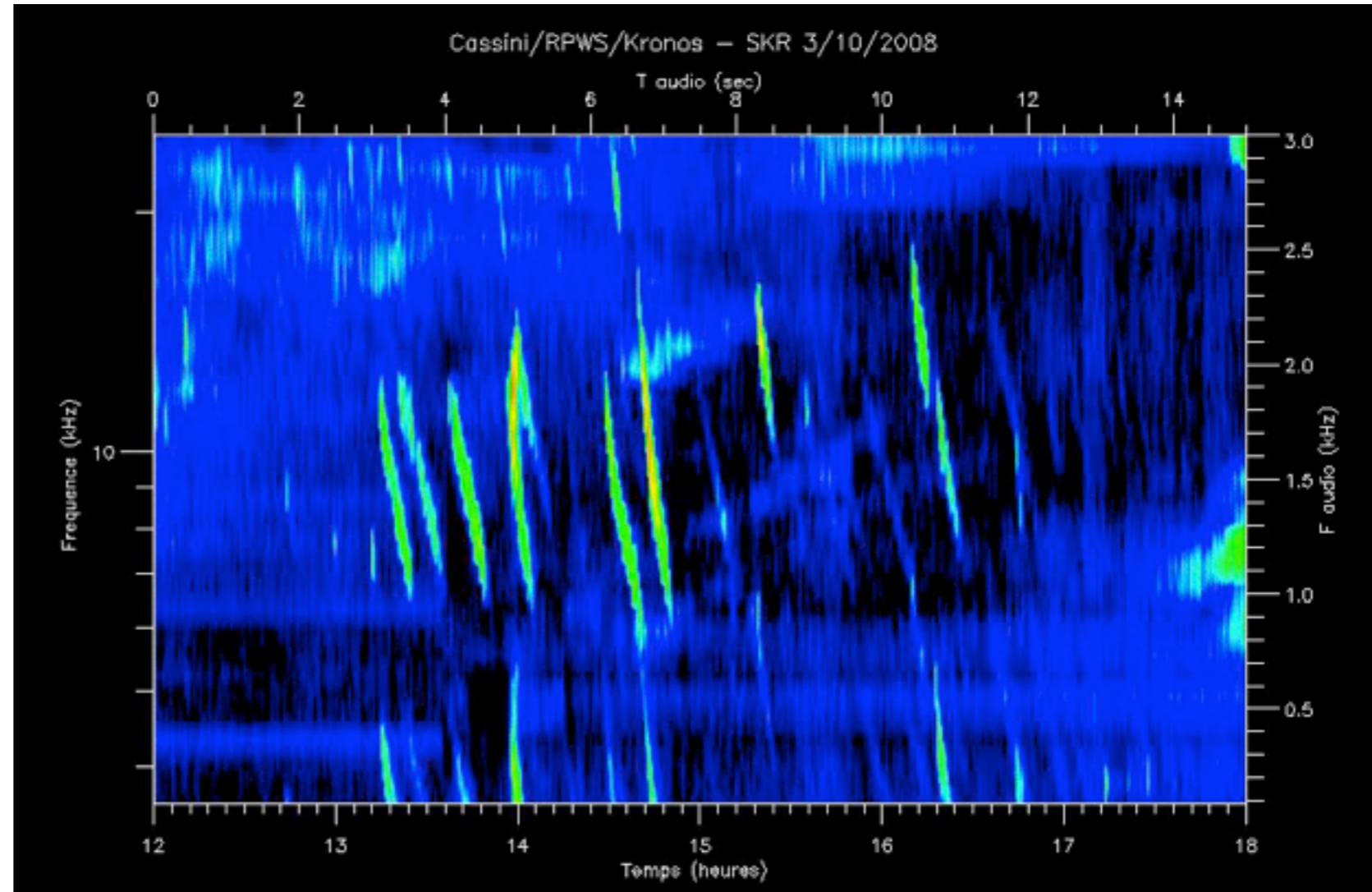
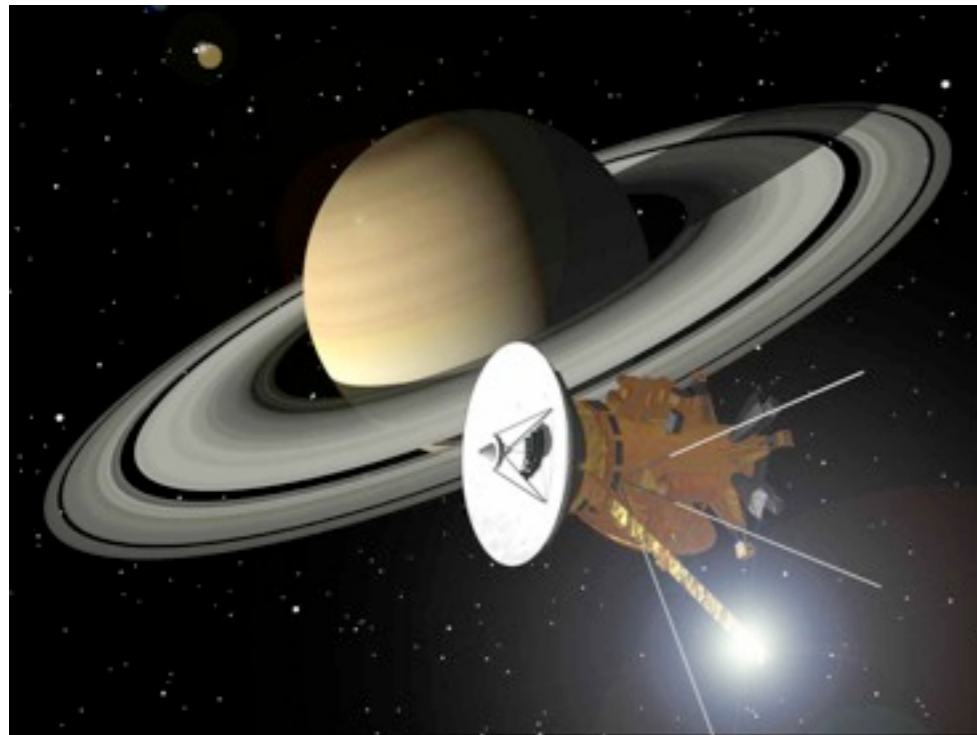
Saturne : 80 minutes-lumière



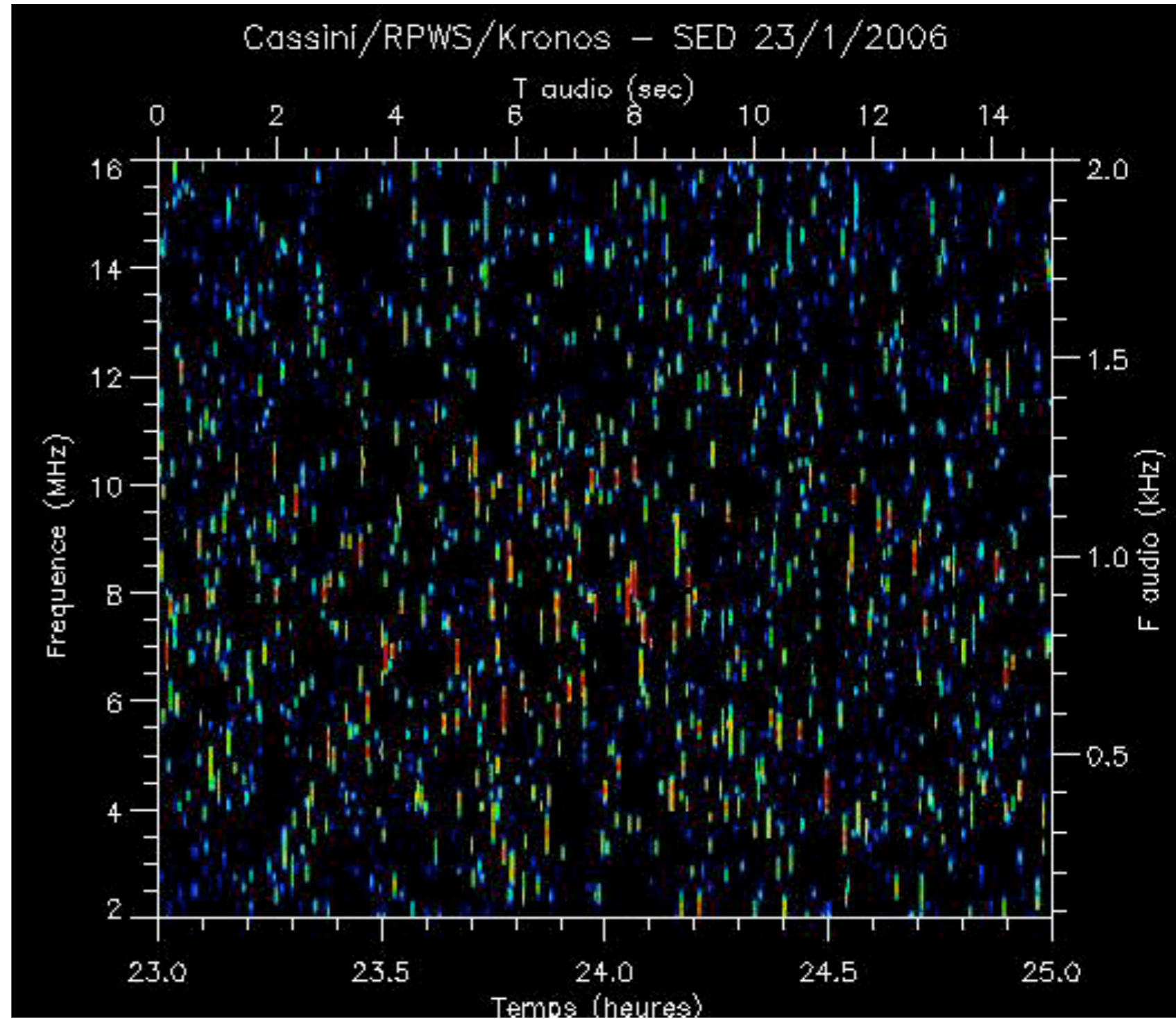
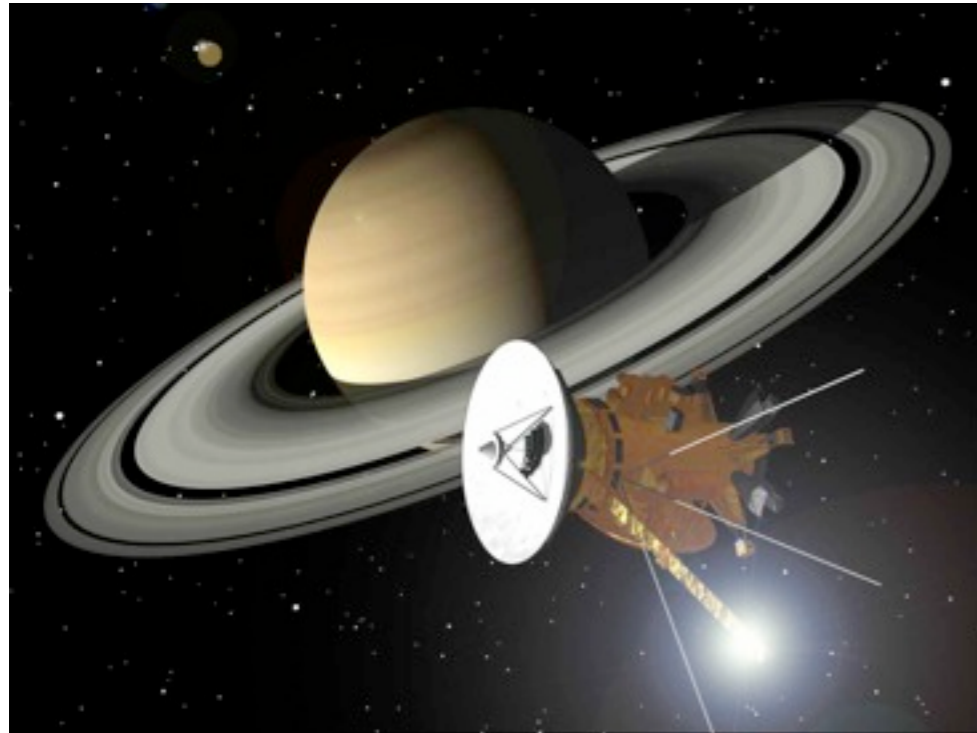
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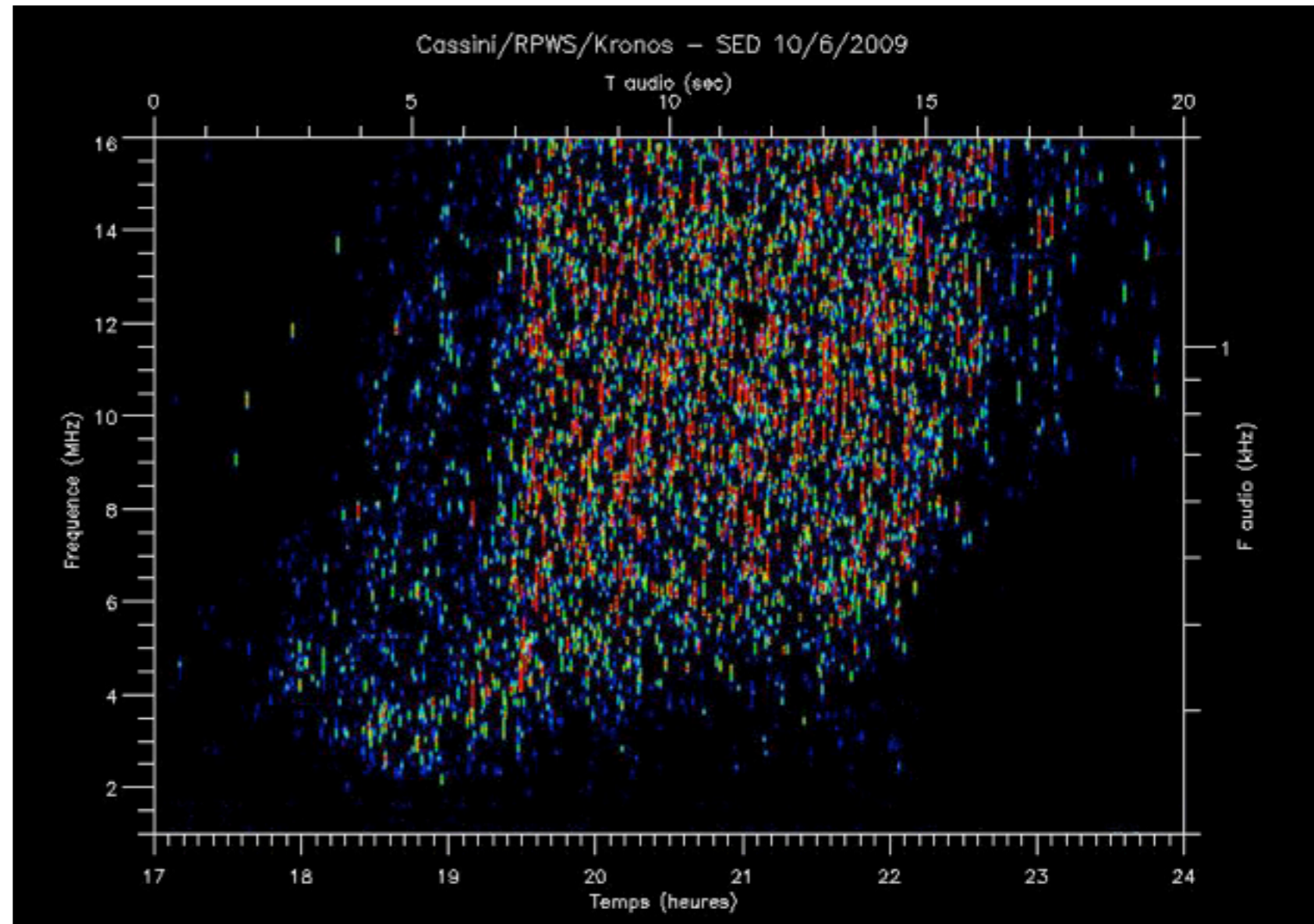
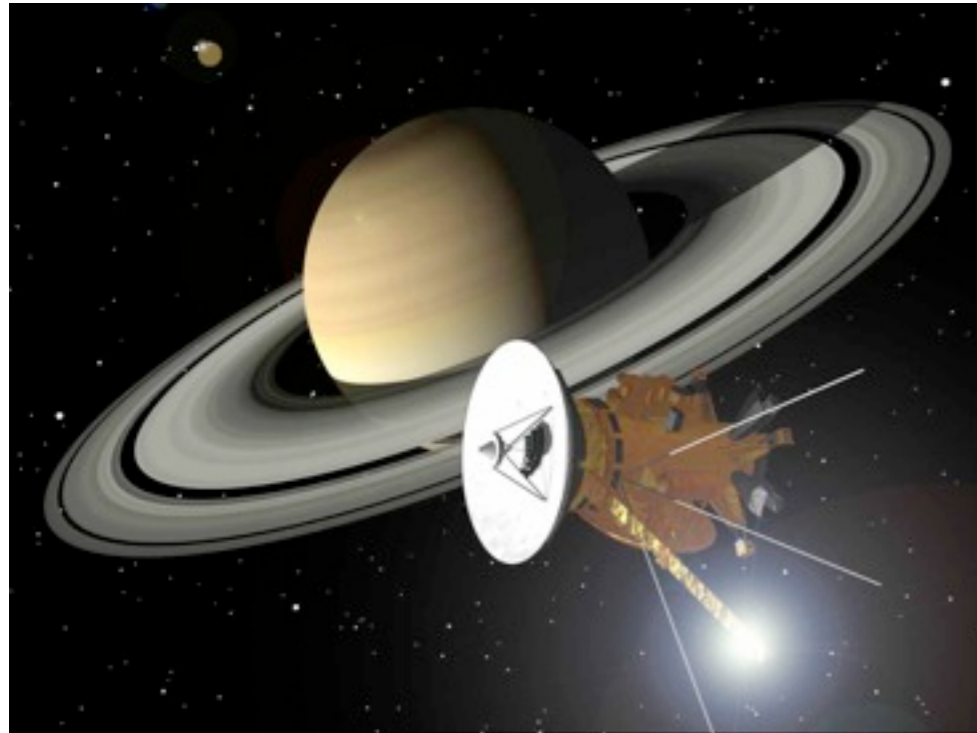
Saturne : 80 minutes-lumière



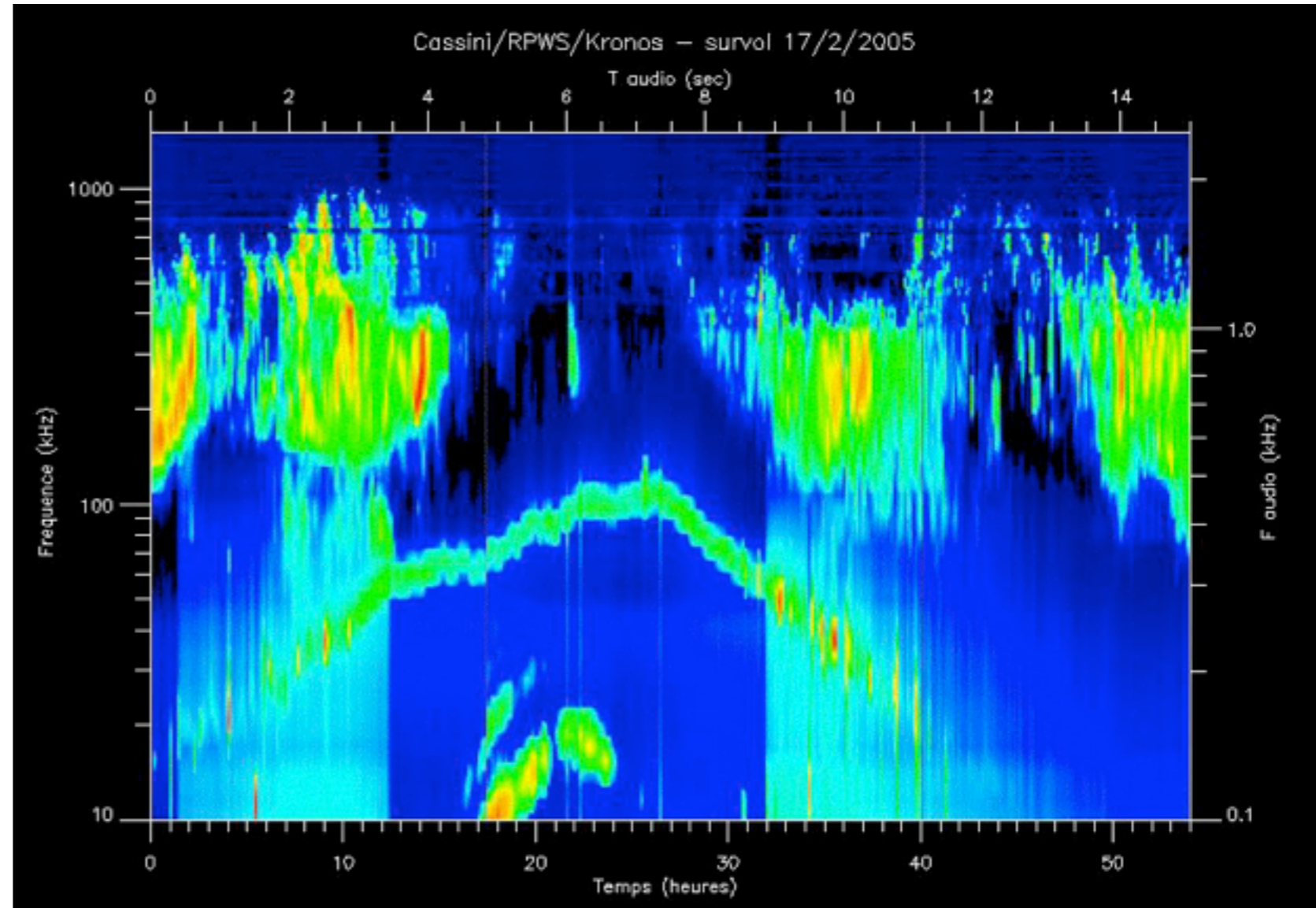
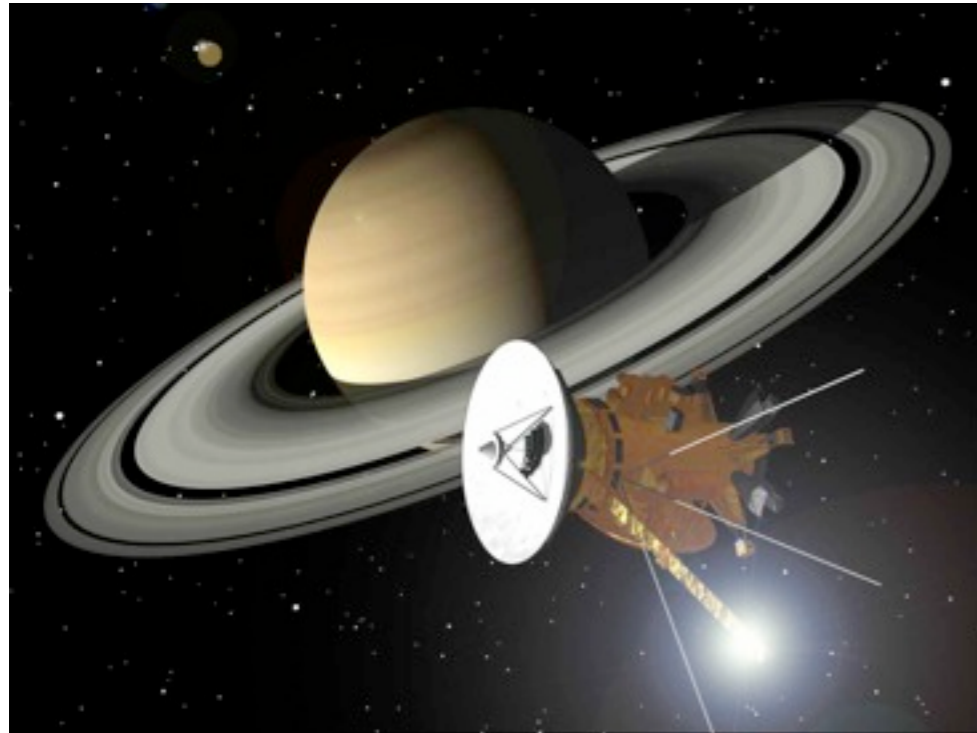
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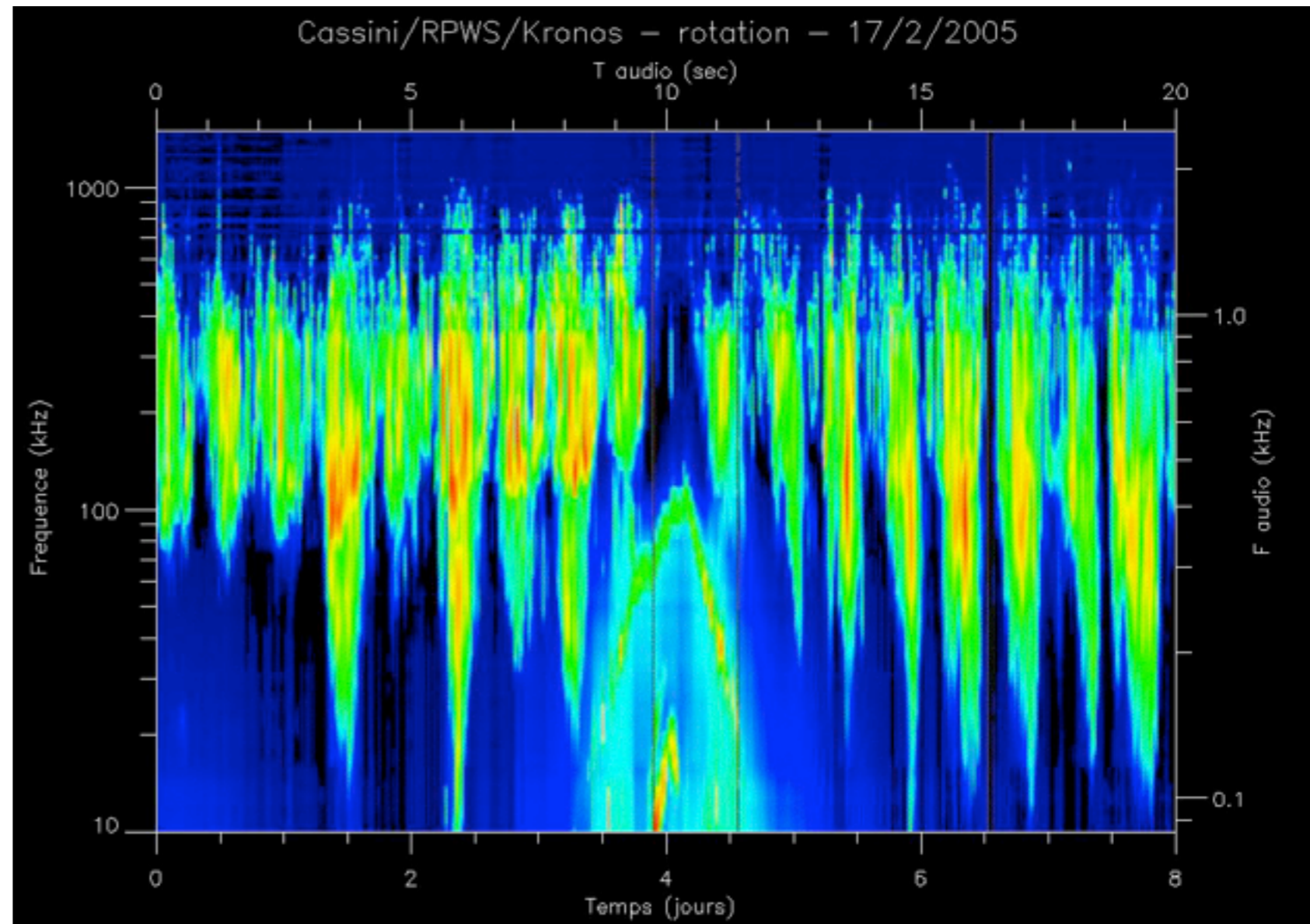
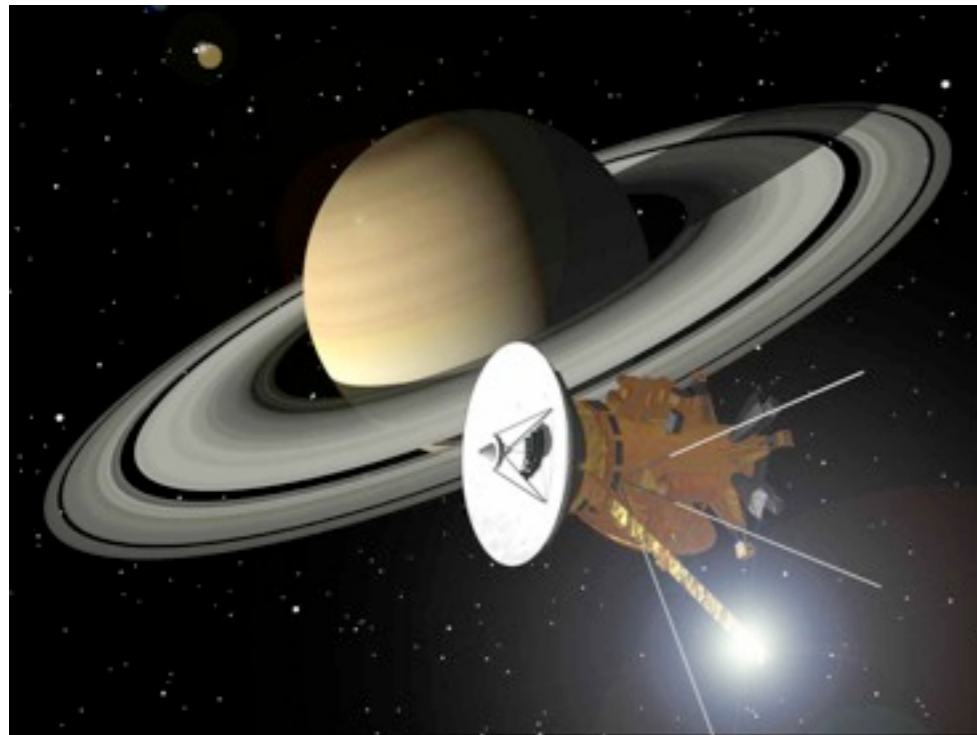
Saturne : 80 minutes-lumière



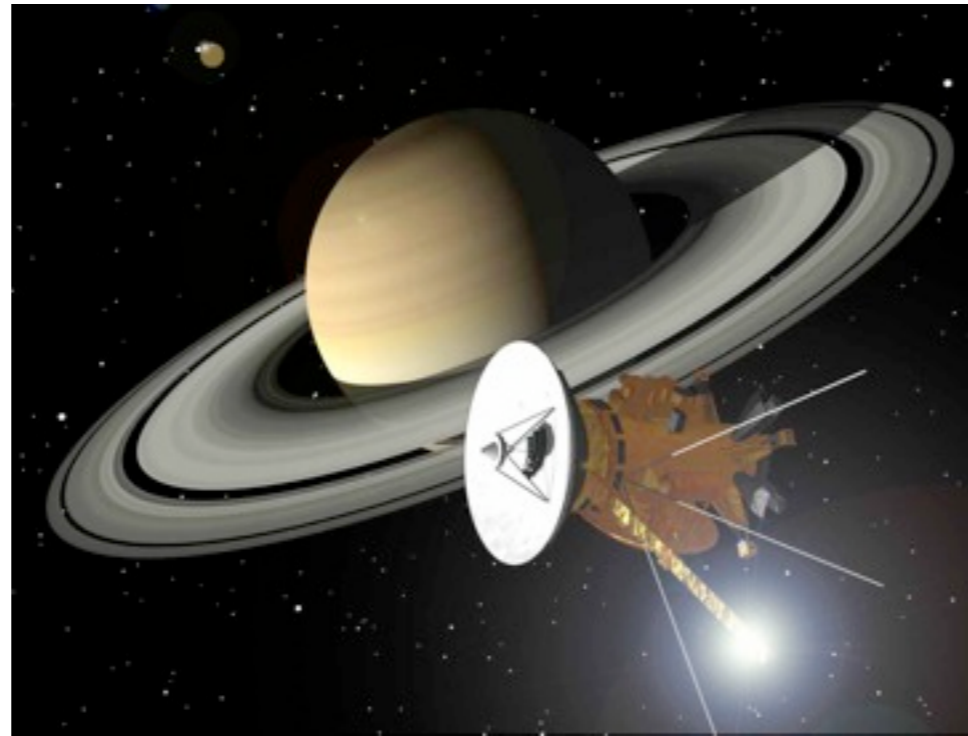
Saturne : 80 minutes-lumière



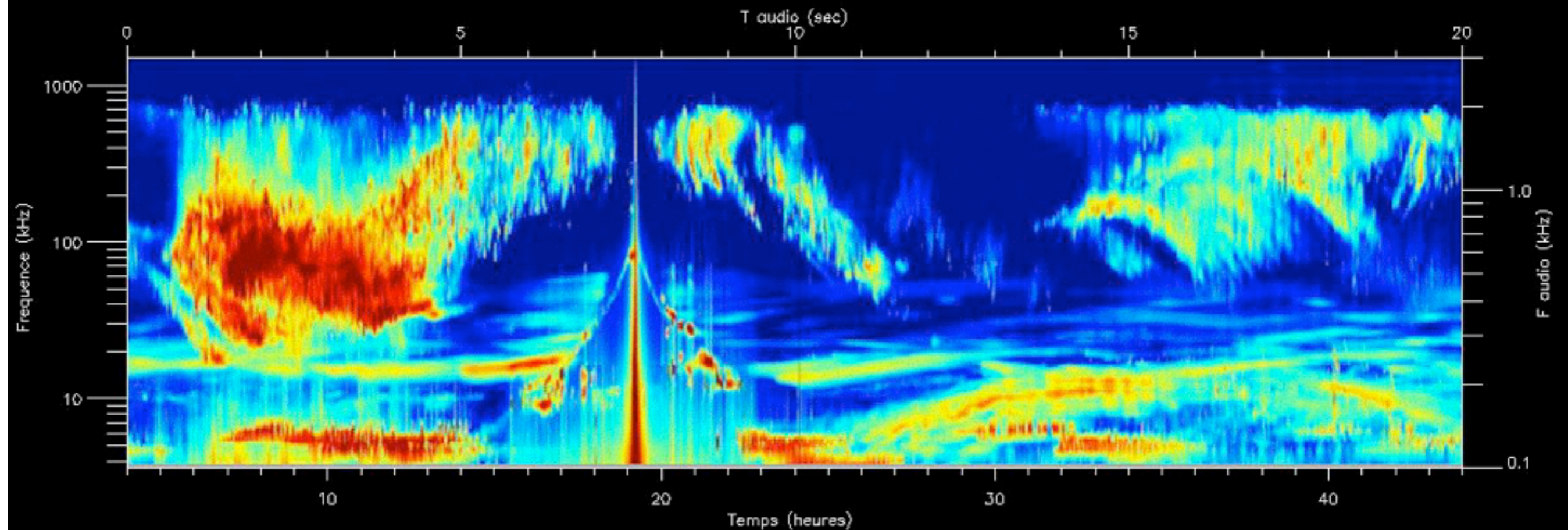
Saturne : 80 minutes-lumière



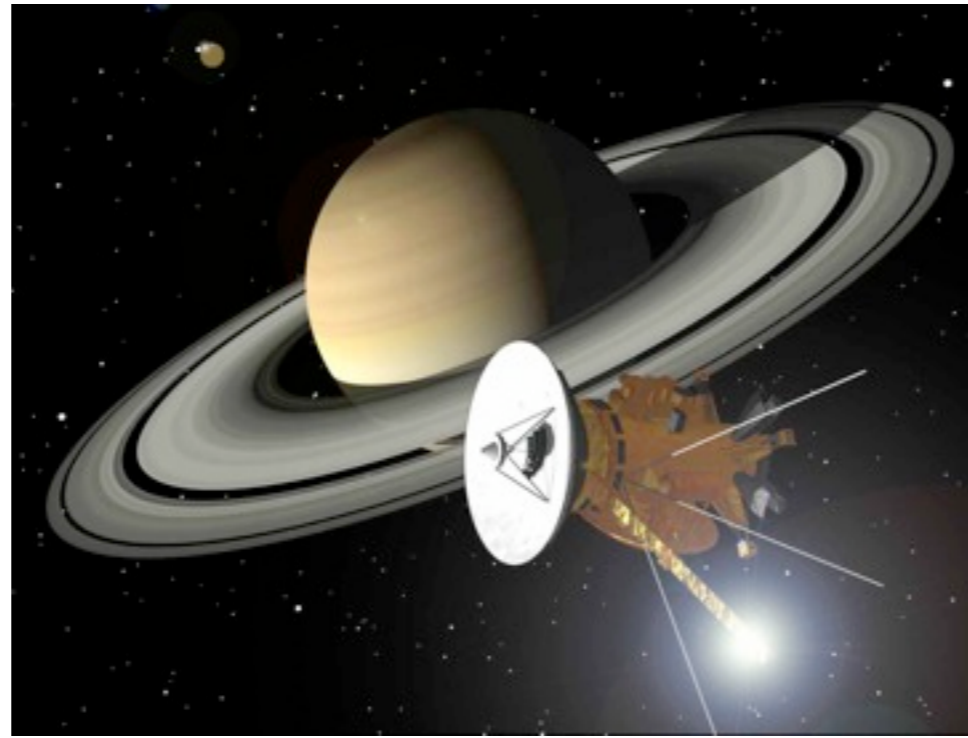
Saturne : 80 minutes-lumière



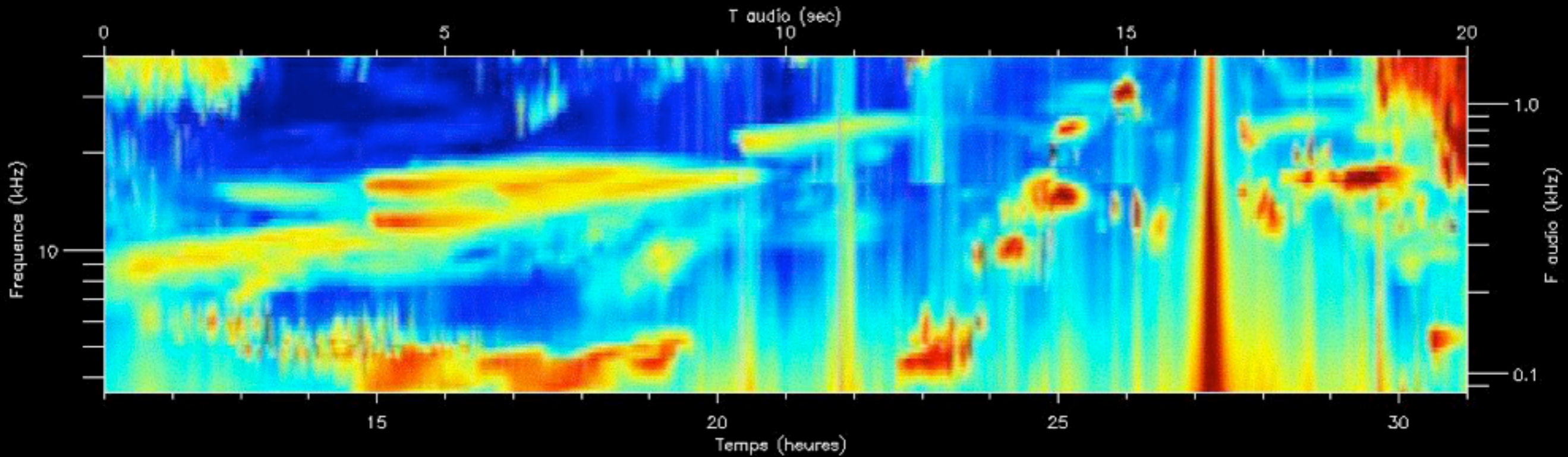
Cassini/RPWS/Kronos – survol 9/10/2008



Saturne : 80 minutes-lumière



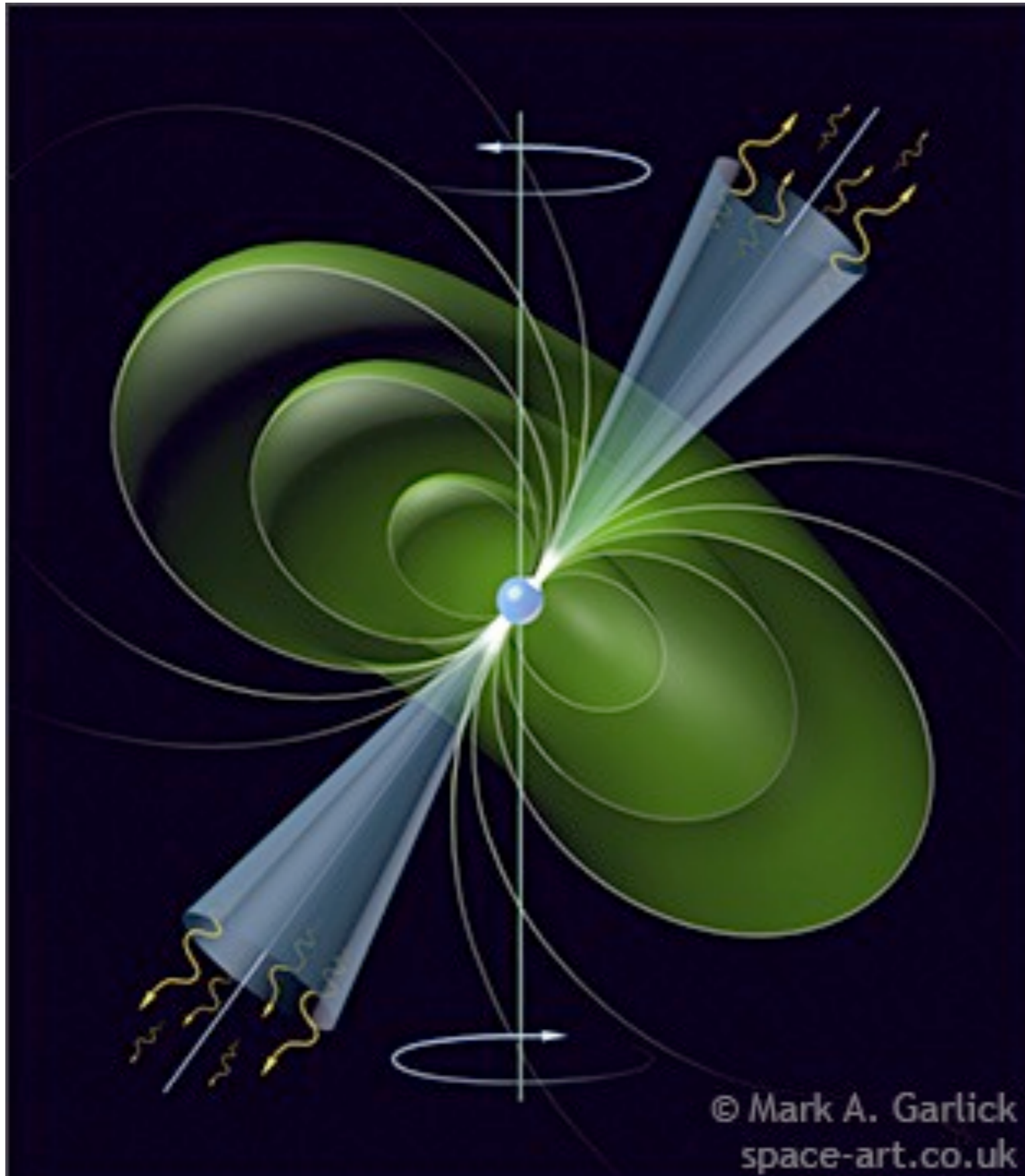
Cassini/RPWS/Kronos – survol 16/10/2008



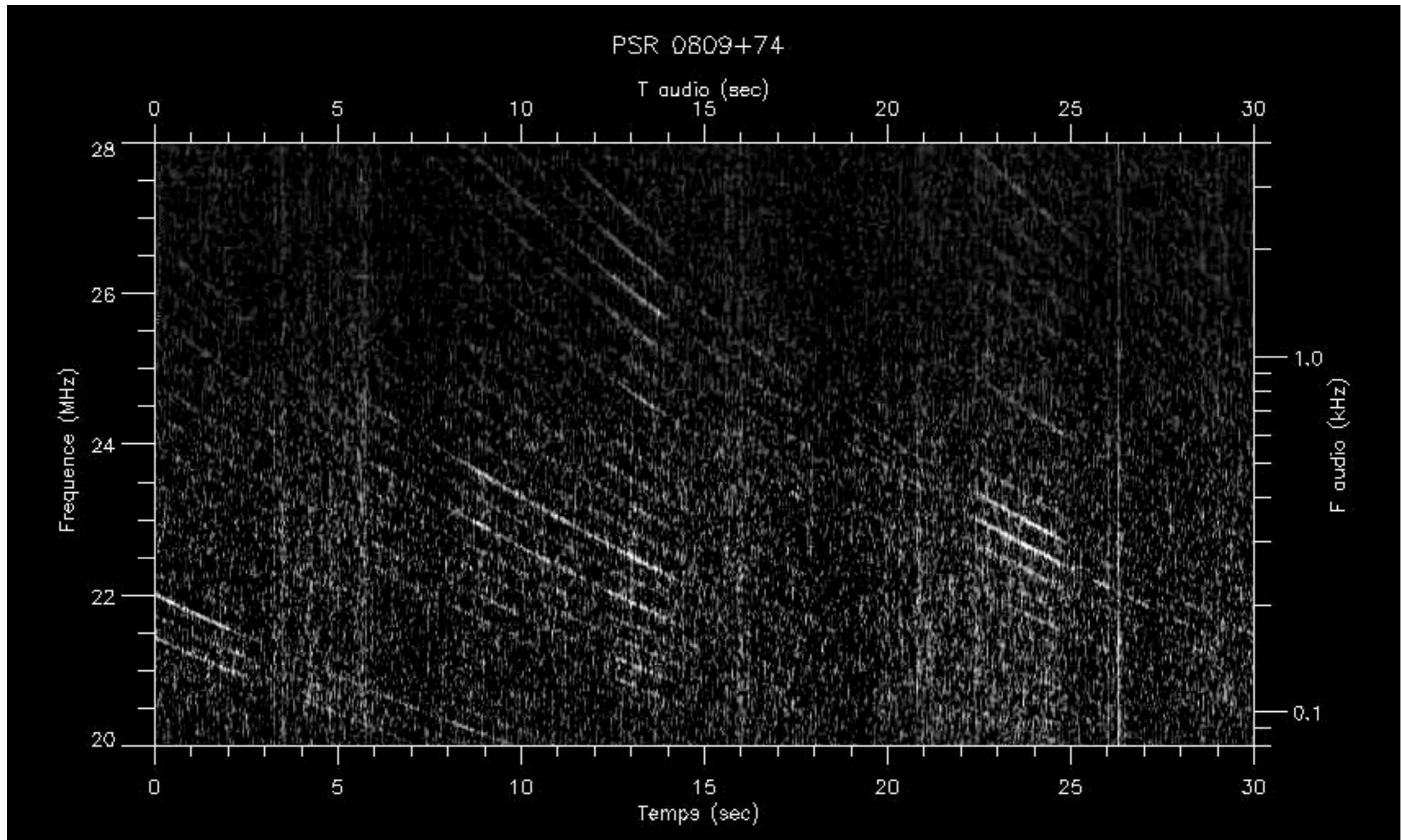
Notre Galaxie



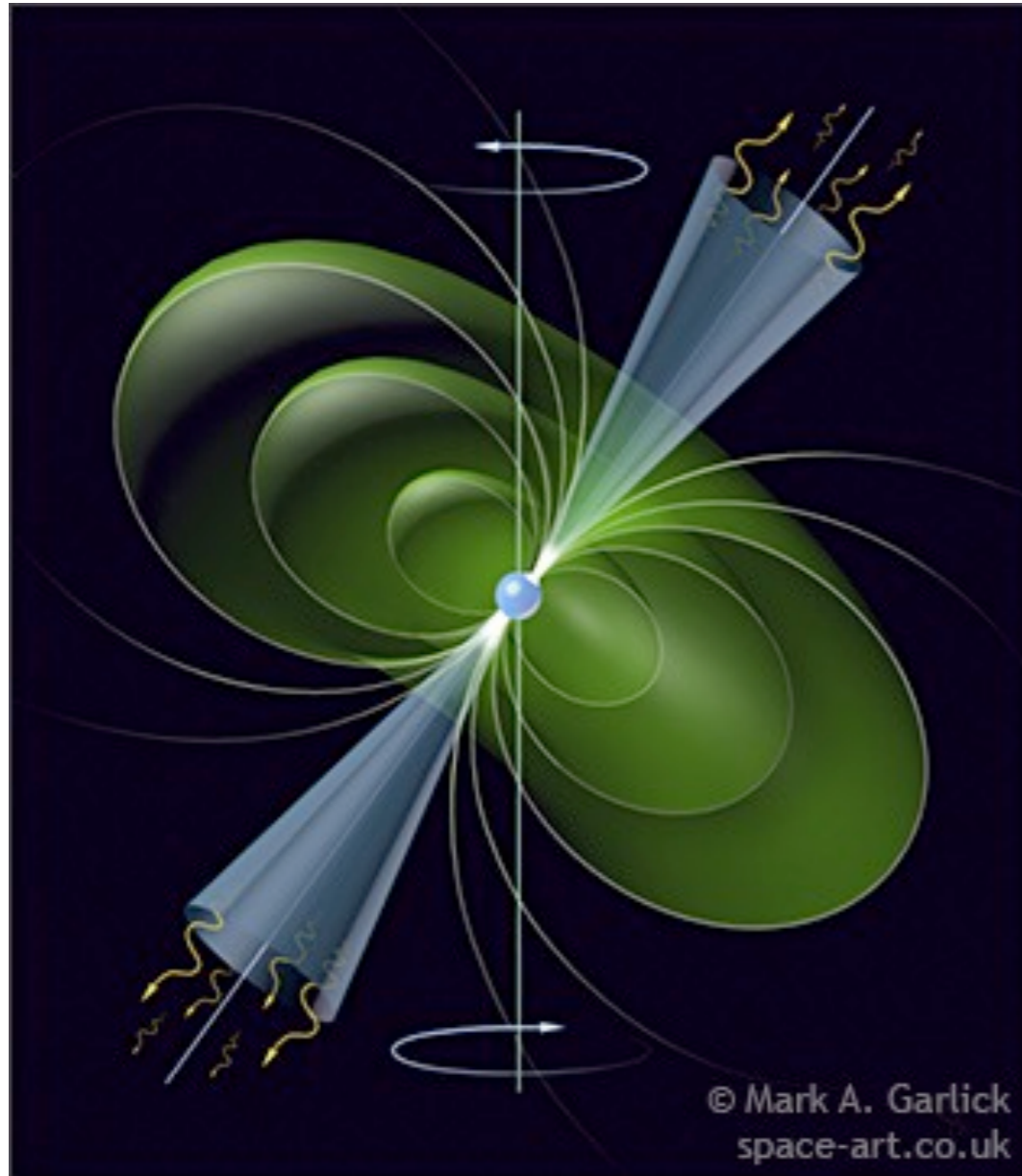
Pulsars



Pulsars (réception)

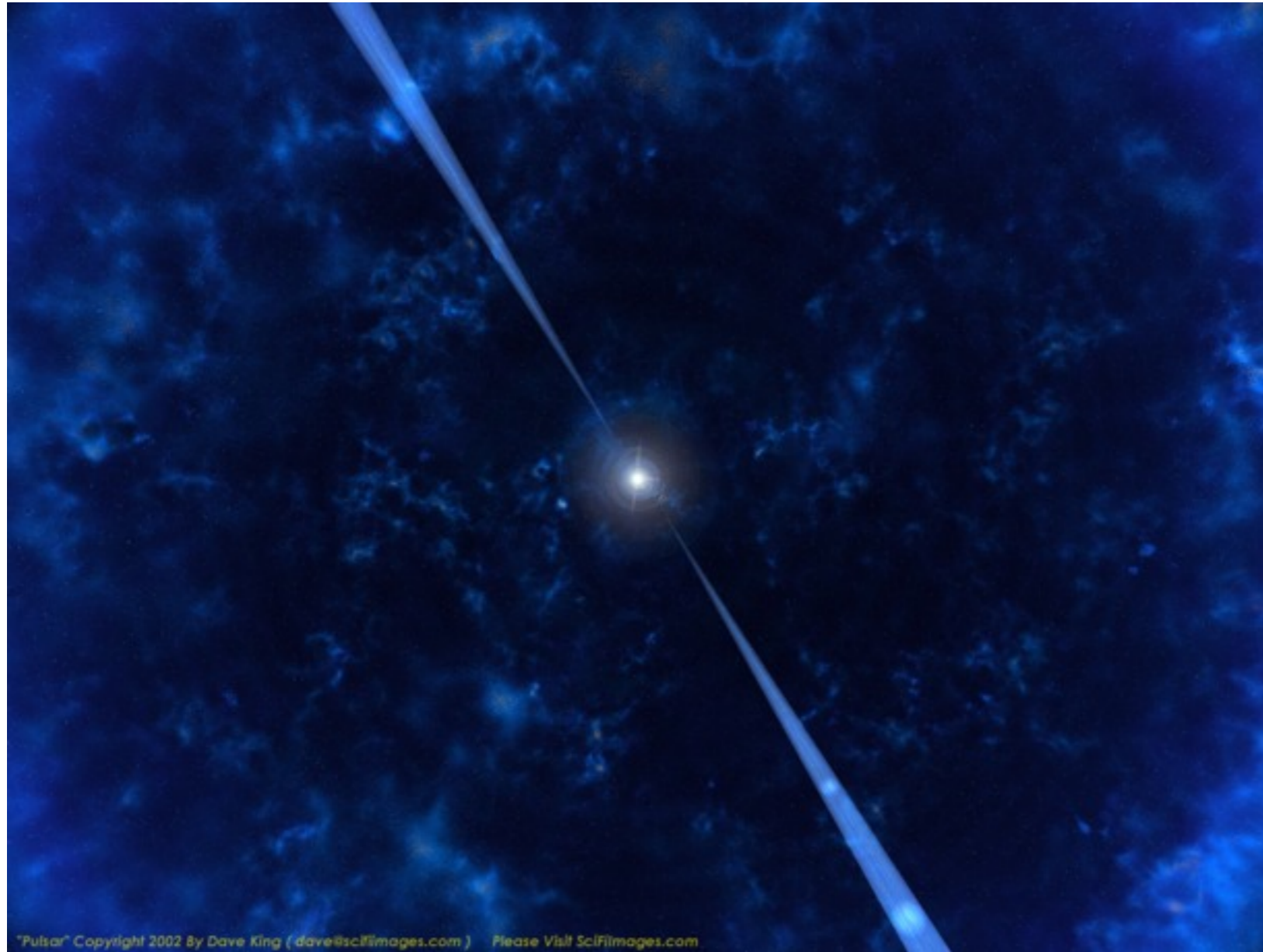


Pulsars (émission)



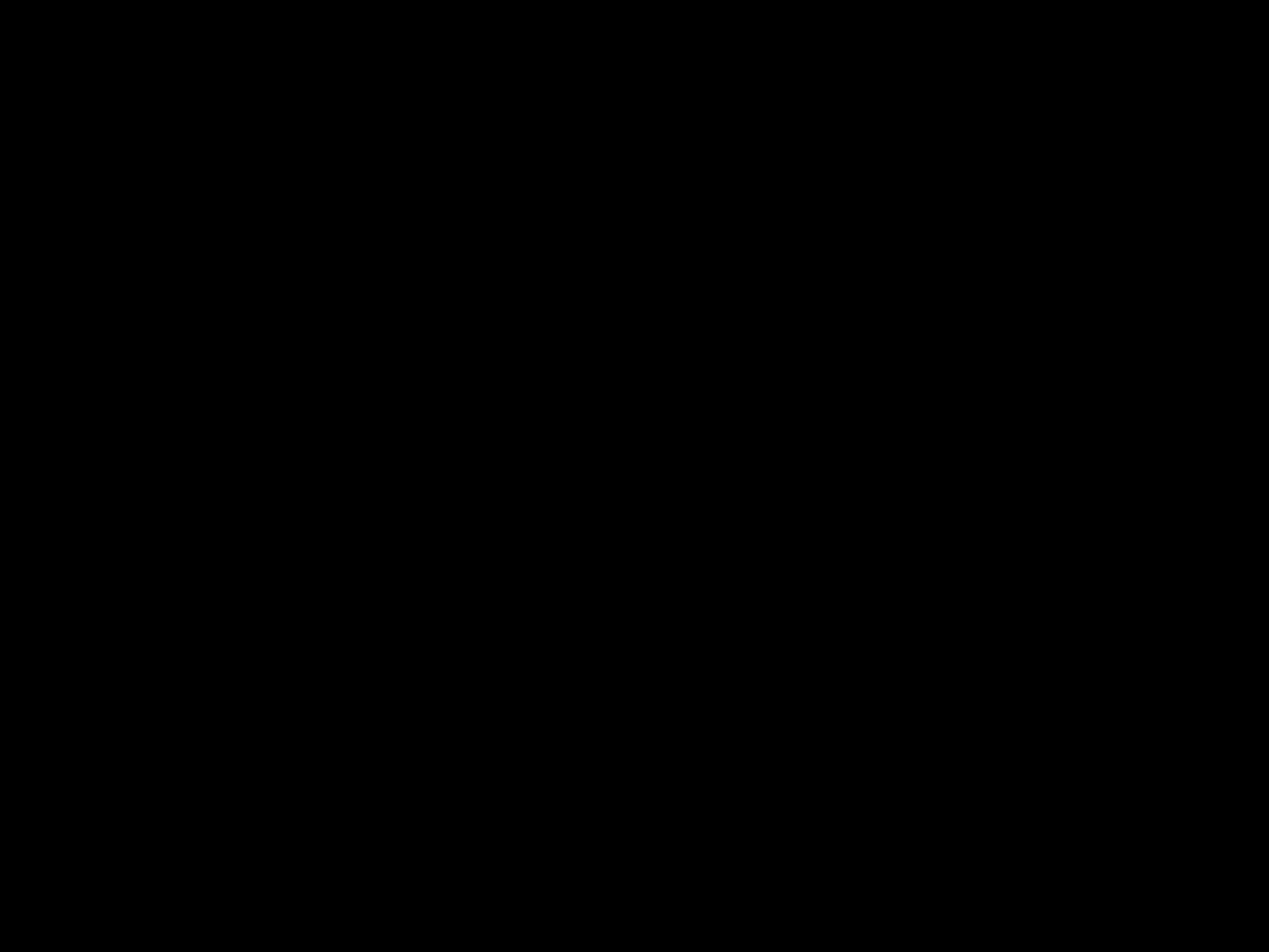
PSR0329+54
(Girafe)
2500 a.l.
715 msec/tour

Pulsars (émission)



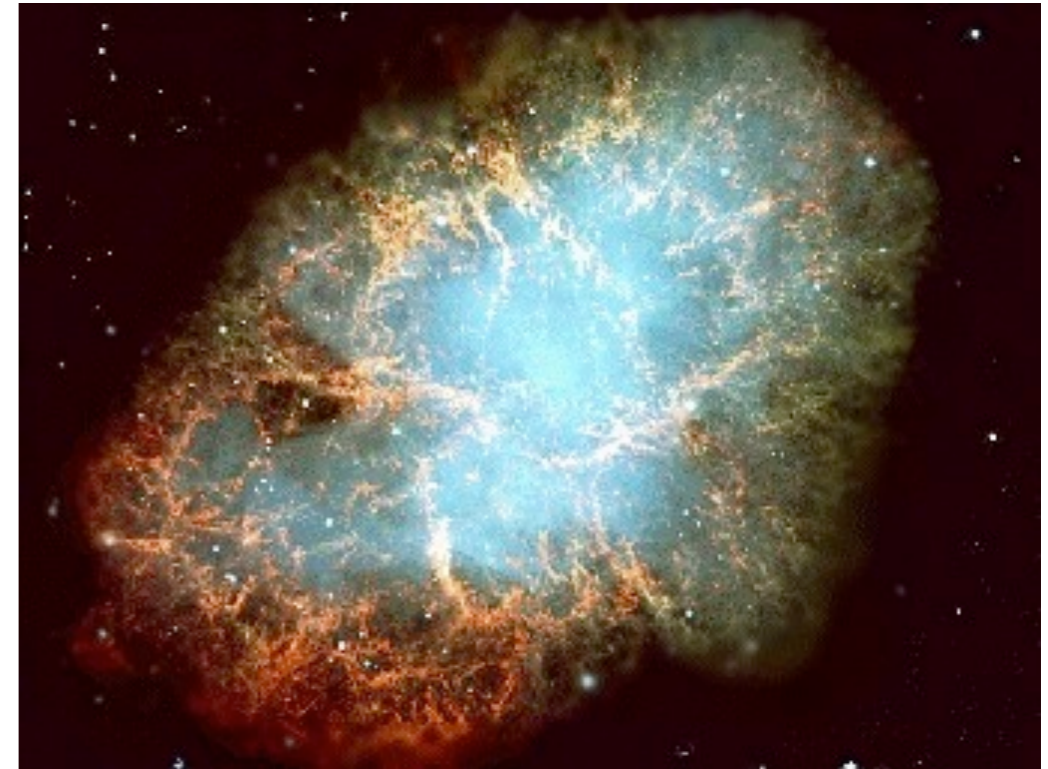
PSR0355+54
6000 a.l.
156 msec/tour

Pulsars (émission)



PSR0833-45
(Vela)
800 a.l.
89 msec/tour

Pulsars (émission)



PSR0531+21 (Crab)

8000 a.l.

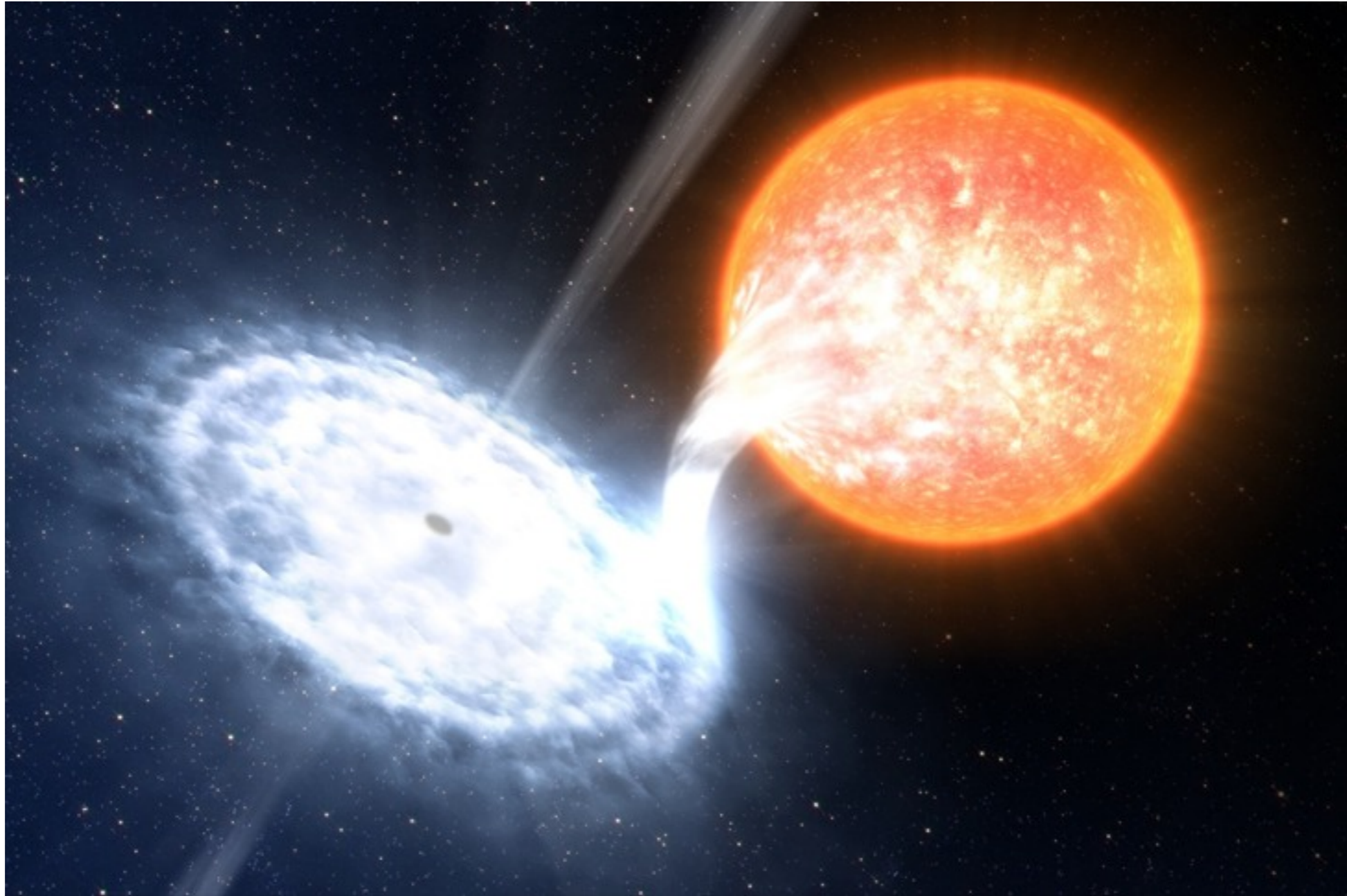
40 msec/tour

Pulsars (émission)



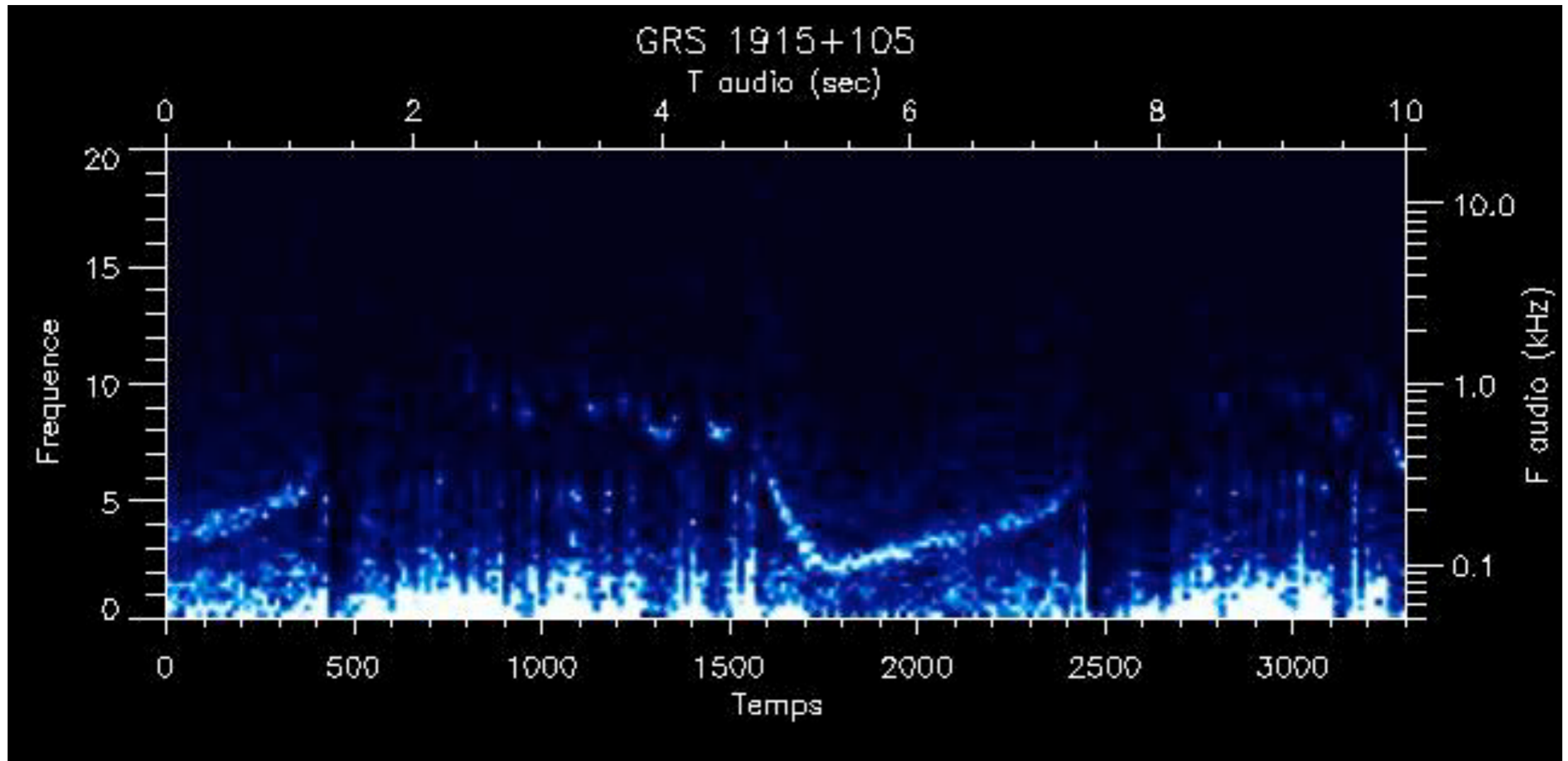
~20 pulsars
millisecondes
dans l'amas globulaire
47 Tucan

Trou noir : le « dernier cri » de la matière



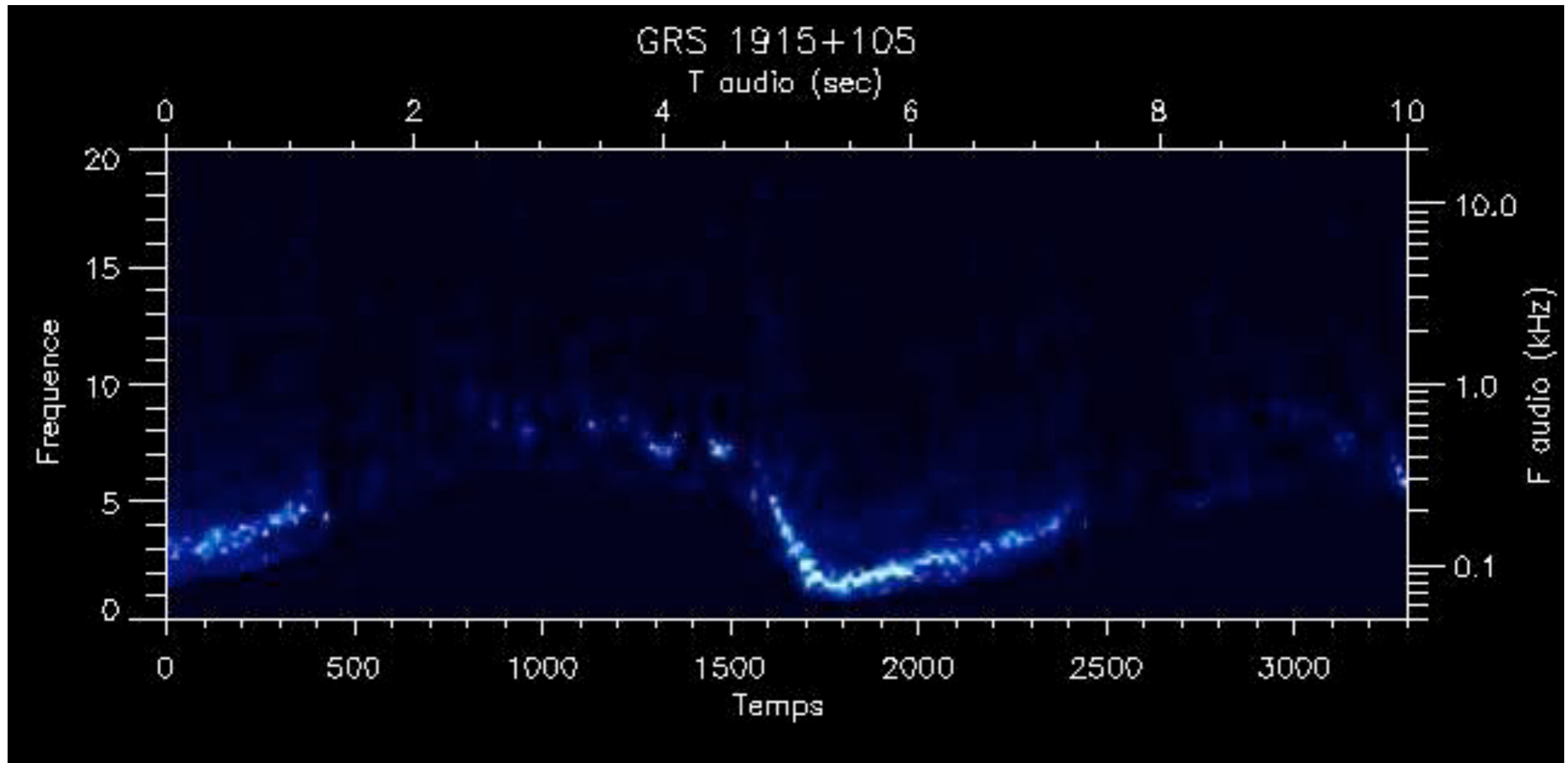
Microquasar GRS1915 en rayons X, à 30000 a.l.

Trou noir : le « dernier cri » de la matière



Microquasar GRS1915 en rayons X, à 30000 a.l.

Trou noir : le « dernier cri » de la matière



Microquasar GRS1915 en rayons X, à 30000 a.l.



« Les chants électriques de l'Univers »

On parle souvent de la "musique des sphères" ou des radiotélescopes comme de "grandes oreilles à l'écoute du cosmos". Or aucun son ne se propage à travers le vide de l'espace. Les astres seraient-ils donc désespérément muets ? Pas nécessairement: ils nous envoient de la lumière, visible et invisible. Or il est possible de "traduire" littéralement les couleurs de cette lumière en sons. Si cette image sonore n'est qu'une illustration de la lumière, elle permet néanmoins de mieux appréhender les informations que cette dernière transporte (fréquences, intensités, spectre, variations temporelles...). Ainsi, les champs électriques de la lumière deviennent les chants électriques qu'elle nous apporte de l'Univers. Grande voyageuse, mais couvrant des distances inimaginables, la lumière nous arrive du passé (proche pour le Soleil, lointain pour les pulsars), et ses chants nous racontent l'histoire de notre Univers. On expliquera tout, et tout deviendra lumineux, avant de se laisser emporter par les chants électriques de l'Univers.