Les couleurs de l'Univers

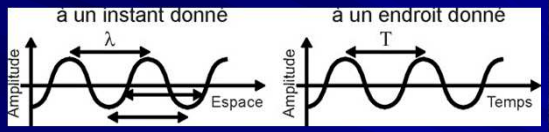
L'Univers multi-longueur d'ondes

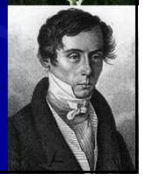
Yaël Nazé

L'Univers multicolore

Rappel : nature de la lumière

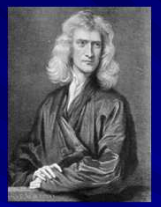
- Onde (cf. son)

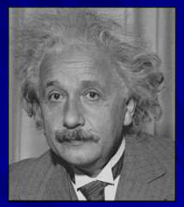




Rappel : nature de la lumière

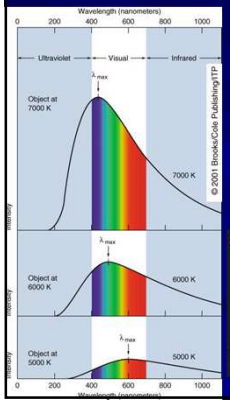
- Flux de particules





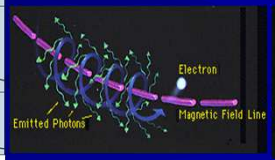
- Ni onde ni particule !
  $E=hc/\lambda$

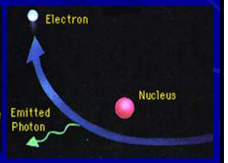
Produire de la lumière !



Grâce

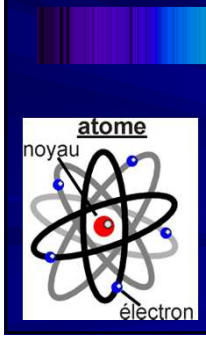
- À la température : corps noir
  ⇒ loi de Wien ! (λT=0.003mK)
- Aux champs magnétiques :
  rayonnement synchrotron
- Aux champs électriques :
  bremsstrahlung

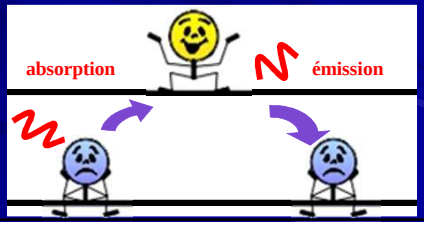




Produire de la lumière ! (2)

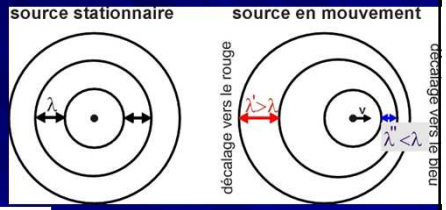
- Raies spectrales

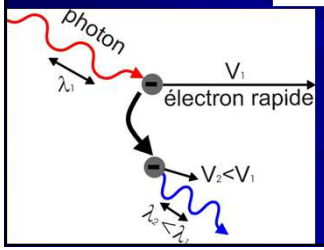




Modifier la lumière !

- Effet Doppler :
  décalage vers le rouge ou le bleu

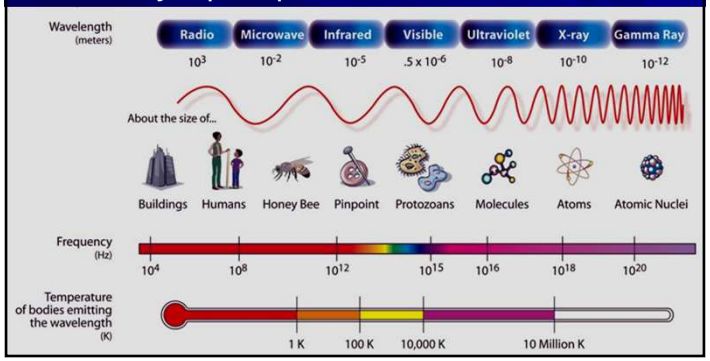




- Effet Compton :
  échange d'énergie

Le spectre électromagnétique

- Il n'y a pas que la lumière visible !

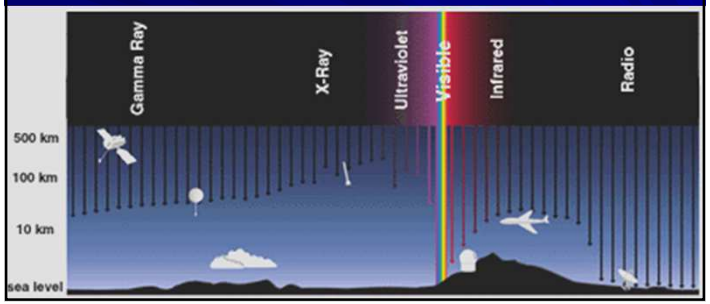


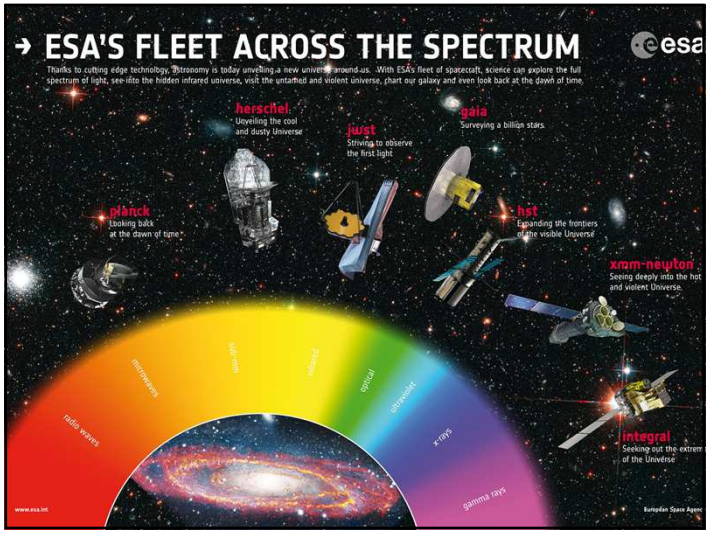
Le spectre électromagnétique

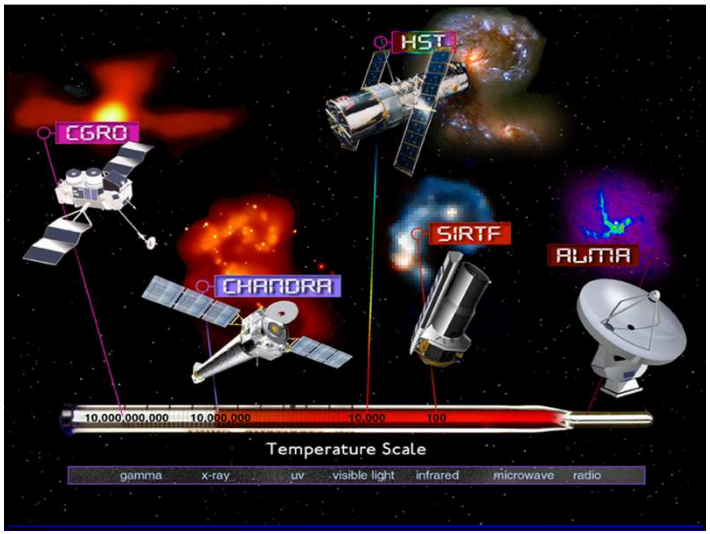
Domaine	λ	Découverte	1er objet astro
Radio	>1mm	1888 H. Hertz	Voie Lactée 1933
IR	0,7μm-1mm	1800 W. Herschel	Soleil 1800
Visible	380-700nm		
UV	10-380nm	1801 J. Ritter	Soleil 1801
Rayons X	0,01-10nm	1895 W. Röntgen	Soleil 1949
Rayons γ	<0,01nm	1900 P. Villard	Soleil 1958

L'espace est nécessaire !

- L'atmosphère nous protège…
  et empêche les astronomes de travailler !

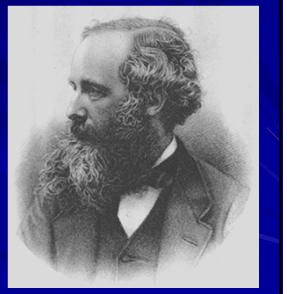






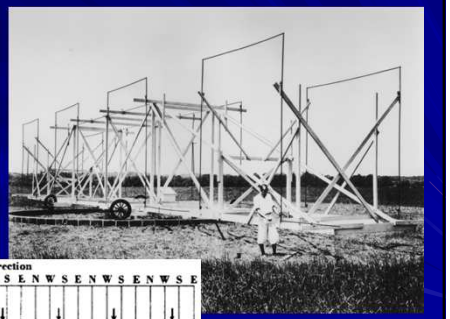
Ondes Radio

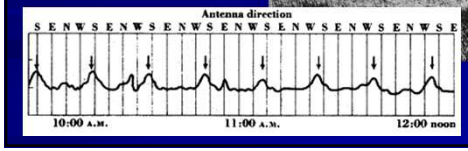
- James Maxwell : la lumière existe avec n'importe quelle longueur d'onde !
- Hertz : des étincelles étranges en 1888



Les petits bruits de l'Univers radio (1)

- Le carrousel de Jansky

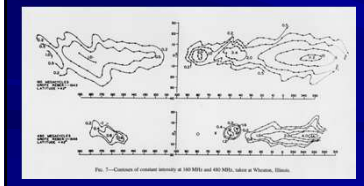




Images NRAO

Les petits bruits de l'Univers radio (2)

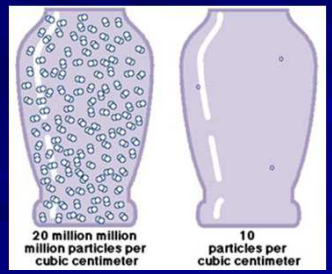
- L'antenne de Reber

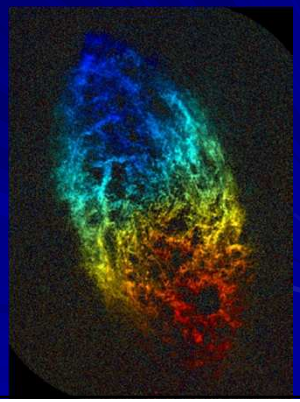


Images NRAO,ApJ

Les petits bruits de l'Univers radio (3)

- Le concours américano-hollandais

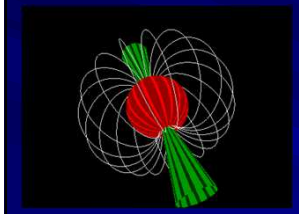


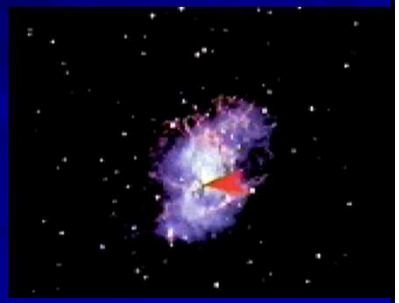


Images NRAO

Les petits bruits de l'Univers radio (4)

- Les drôles d'étoiles de Bell !

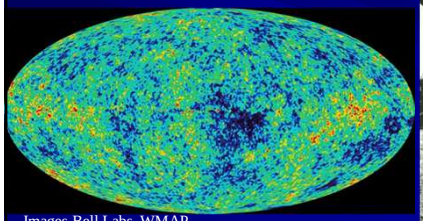




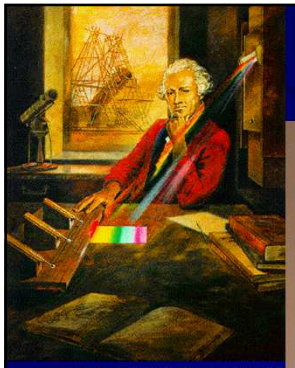
Images Cosmic Search, HEASARC

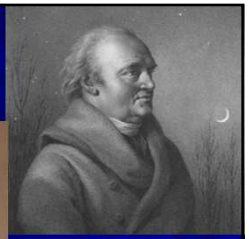
Les petits bruits de l'Univers radio (5)

- Le bruit de fond cosmologique !



Images Bell Labs, WMAP



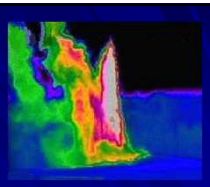


L'Infrarouge

William Herschel et ses thermomètres 1800

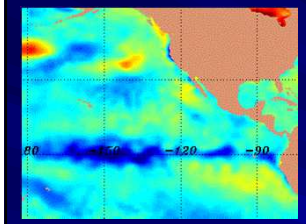
Images ESA, IPAC

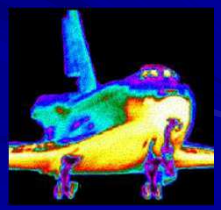
IR et chaleur



Images IPAC

On utilise l'infrarouge tous les jours !

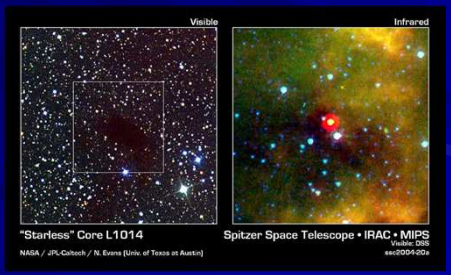




Images IPAC

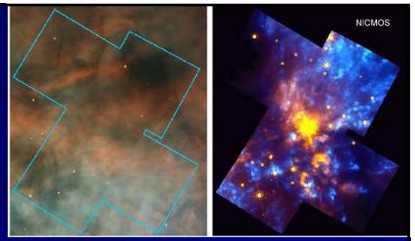
L'astronomie IR

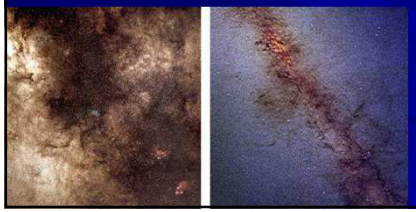
- Principalement du rayonnement thermique
- Idéal pour les planètes et les bébés-étoiles

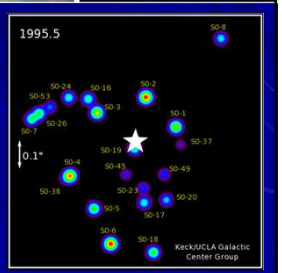


L'astronomie IR

- Permet de voir derrière les poussières





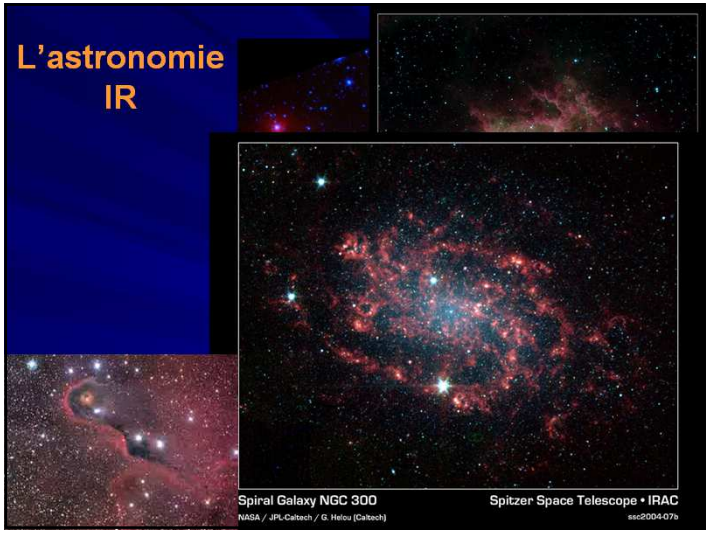


Images HST, 2MASS, ESO

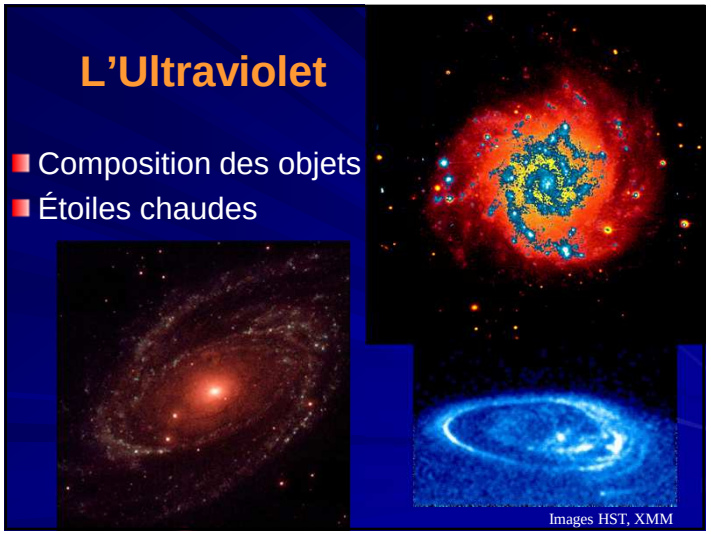
L'astronomie IR

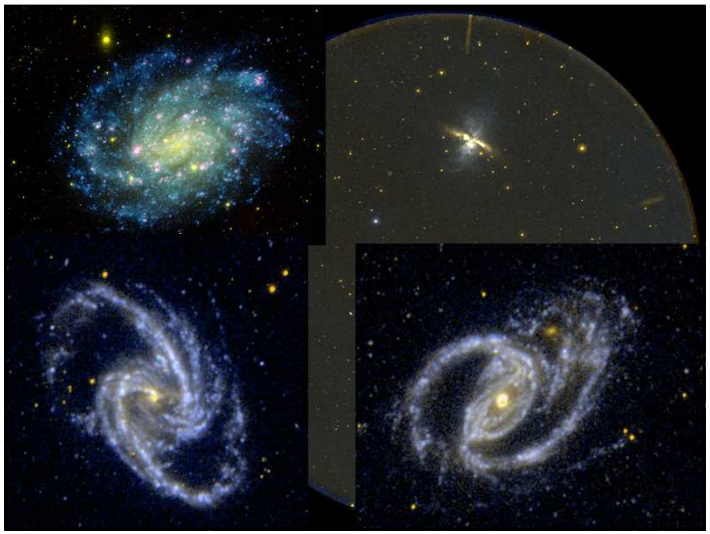
- Permet d'observer la matière interstellaire

Images 2MASS

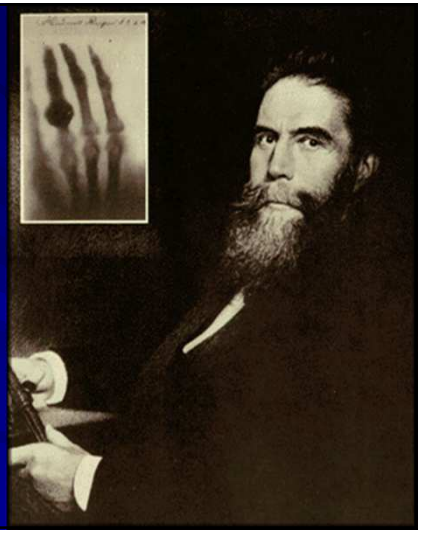

L'astronomie IR
Spiral Galaxy NGC 300
NASA / JPL-Caltech / G. Helou (Caltech)
Spitzer Space Telescope • IRAC
ssc2004-07b

L'Ultraviolet
Le symétrique de l'IR !
Johann Ritter 1801
William Wollaston 1802


L'Ultraviolet
Composition des objets
Étoiles chaudes
Images HST, XMM



Les Rayons X

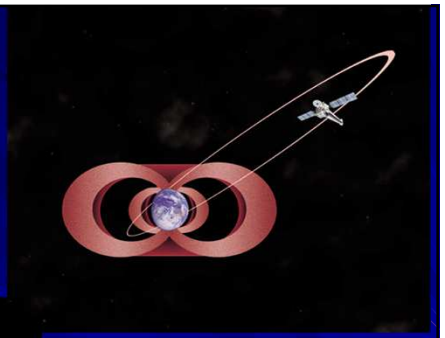


- Wilhelm Röntgen et l'écran qui brillait…
  1895

Les télescopes X

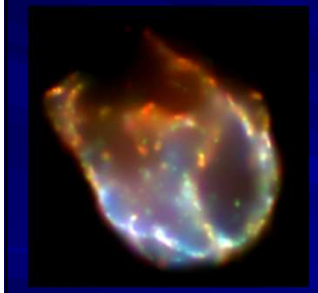
Image Chandra

Loin là-haut…



Images Chandra

La violence de l'Univers

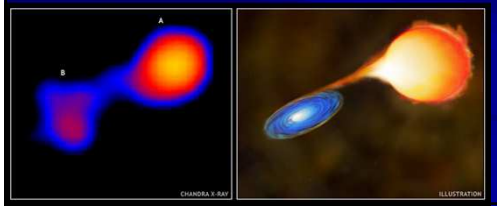


- Explosions en tout genre

Images XMM, Chandra

La violence de l'Univers

- Les étoiles cannibales (binaires X, variables cataclysmiques)



Images Chandra

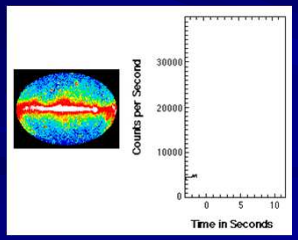
Les Rayons γ

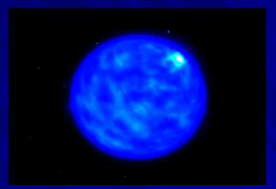
- Paul Villard 1900
- Des processus hors du commun !

L'astronomie γ

- Violence **extrême** !

Les sursauts γ

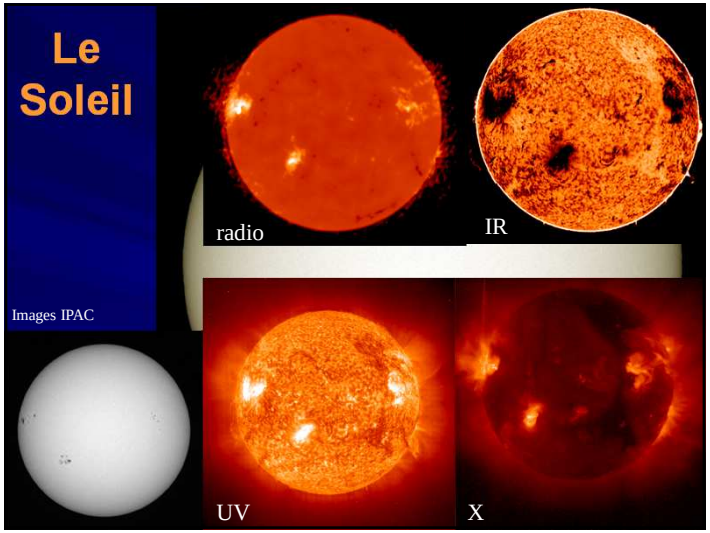




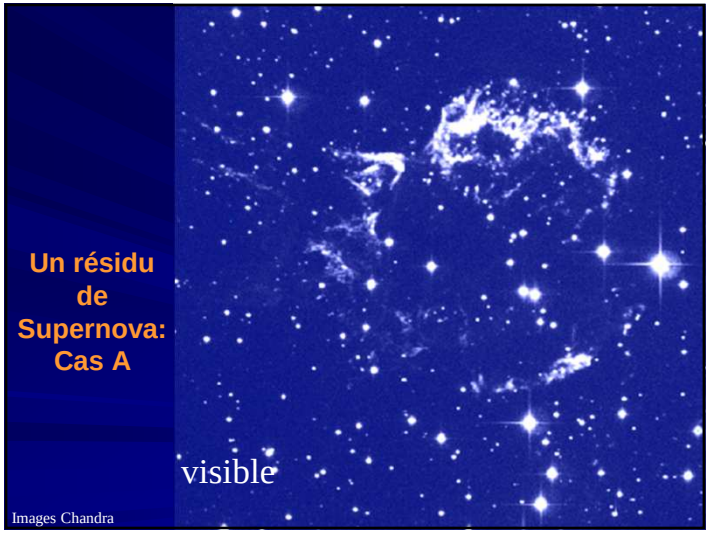
Portraits à travers l'arc-en-ciel

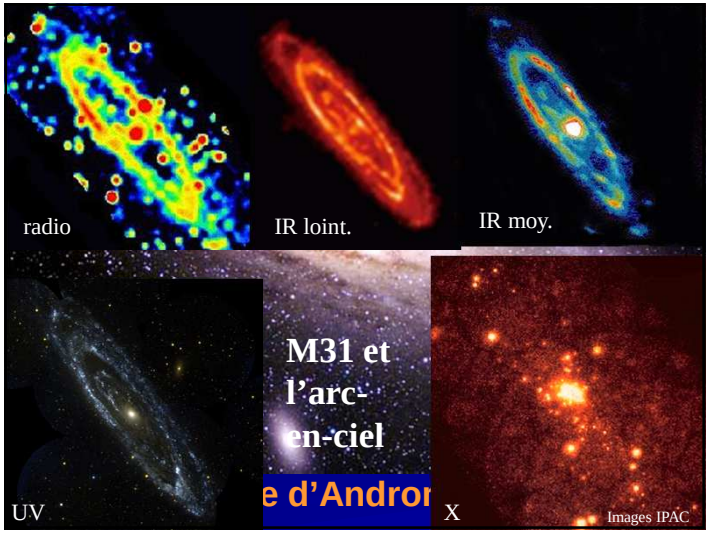
- Du radio aux rayons gamma…
  À quoi ressemble le ciel ?

Le Soleil

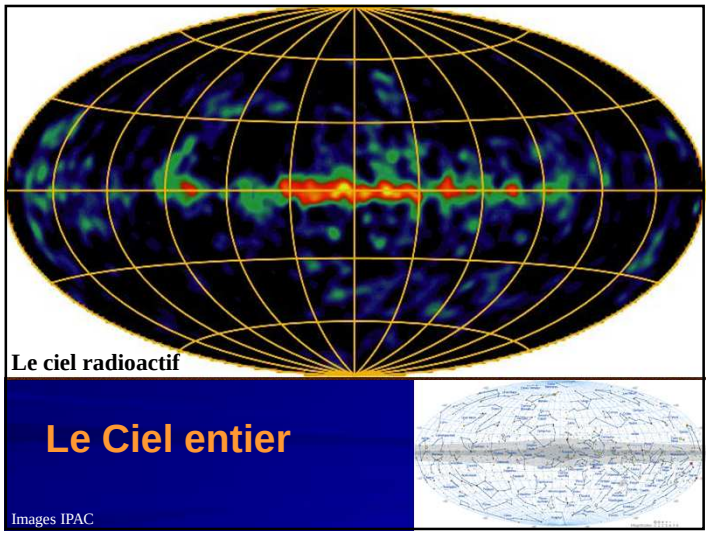


Un résidu de Supernova: Cas A




radio
IR loint.
IR moy.
UV
M31 et
l'arc-
en-ciel
e d'Andror
X
Images IPAC

IR proche
Une galaxie
étrange: Cen A
UV
IR moyen
visible
X
Gamma
Radio
Images VLA, 2MASS, AAO, GALEX,
Chandra, COMPTEL


Le ciel radioactif
Le Ciel entier
Images IPAC

Retour sur Terre… en 1950
Gamma (hte E)
Images PvB

Au-delà de l’arc-en-ciel

D’autres « nouvelles astronomies » :

- Neutrinos
- Ondes gravitationnelles