« Comment les informations recueillies par le satellite Planck permettent-elles de cartographier "l'Univers fossile" ? »

VERSION DNL du sujet zéro et barême

Des documents originaux (à l'exception du document 2) donnant les mêmes informations remplacent les documents en français du sujet. Le document en anglais n'a bien évidemment pas été modifié !

*La phrase ,"*The CMB appears as an almost constant black body with a temperature of 3 K." *a été transformée en* "The CMB appears as emitted by an almost constant black body with a temperature of 3 K." http://planck.cf.ac.uk/glossary

Le passage concernant les nids de pigeons du document 5 peut-être supprimé… même s'il intéresse les élèves…

Aide :

Présenter le satellite Planck et sa mission. Préciser ensuite les principales caractéristiques du rayonnement fossile (source, nature, intensité et direction, longueur d'onde dans le vide au maximum d'intensité λ_{max}). Justifier alors l'intérêt de réaliser des mesures hors de l'atmosphère et conclure en expliquant notamment le lien entre cartographie du rayonnement et cartographie de l'Univers.

1.

Planck is a space observatory operated by the European Space Agency (ESA), which was launched in 2009. The final deactivation command was sent to Planck in October 2013.
It was named in honour of the German physicist Max Planck (1858–1947), who won the Nobel Prize in Physics in 1918. Adapted from Wikipedia

2.

Wien's law. $\lambda_{max}.T = A$

For each temperature of the black body, there is a peak in the black body curve at a wavelength called the peak wavelength, λ_{max}
T is the temperature in Kelvin
A = 2,9 mm.K (mm.K is a millimetre.kelvin).

3.

Planck was designed to map the sky. Cosmologists using ESA's Planck satellite have compiled the most accurate image so far of the Cosmic Microwave Background (CMB), the most ancient light observed in the history of the Universe, emitted only 380,000 years after the Big Bang.
By exposing minute* differences in the CMB temperature over the entire sky to unprecedented detail, the new Planck image provides a unique snapshot of the slightly mottled** Universe as it was when the CMB was released.
The pattern of fluctuations observed in the CMB carries a record of the cosmic seeds*** that were produced immediately after the Big Bang, and that would later evolve into all the structure observed in the Universe today – from stars and planets to galaxies and galaxy clusters.

** minute = very small* ***mottled ; tacheté* **** seed = germe*

http://sci.esa.int/planck/51551-simple-but-challenging-the-universe-according-to-planck

4.

Cosmic Microwave Background (*CMB* for short):
The afterglow* of the Big Bang, showing the Universe as it was around 400,000 years after the Big Bang.
The CMB appears as an almost constant black body with a temperature of 3 K.
Tiny fluctuations contain information about the age, structure and evolution of the Universe.

** glow = rayonnement*

http://planck.cf.ac.uk/glossary

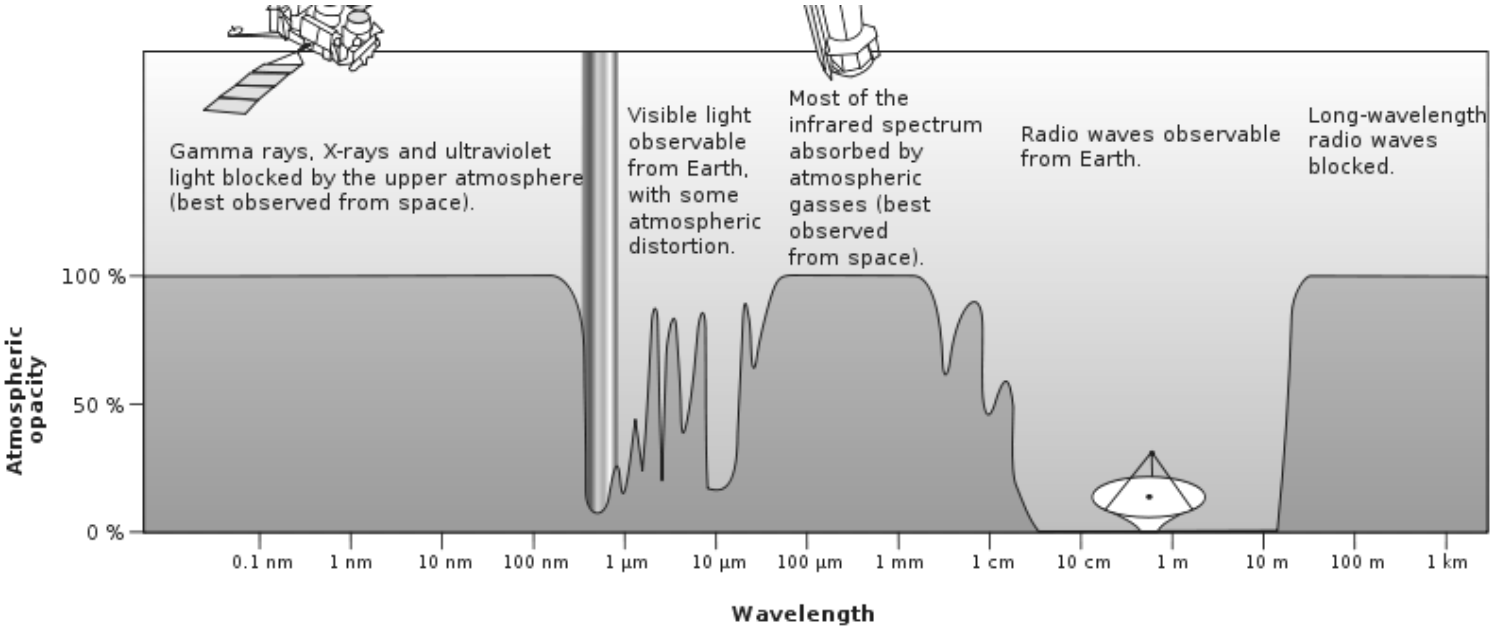
Dominique Noisette Clermont Ferrand

5.

Arno Penzias and Robert Wilson were experimenting with a supersensitive antenna originally built to detect radio waves bounced off Echo balloon satellites*. To measure these faint radio waves, they had to eliminate all recognizable interference from their receiver. They removed the effects of radar and radio broadcasting, […] but found a low, steady, mysterious noise that persisted in their receiver. This residual noise was 100 times more intense than they had expected, was evenly spread over the sky, and was present day and night. They were certain that the radiation they detected […] did not come from the Earth, the Sun, or our galaxy. After thoroughly checking their equipment, removing some pigeons nesting in the antenna and cleaning out the accumulated droppings, the noise remained. Both concluded that this noise was coming from outside our own galaxy. Wikipedia

**These satellite functioned as a reflector, so that after it was placed in a low Earth orbit, a signal would be sent to it, reflected or bounced off its surface, and then returned to Earth.(Wikipedia)*

6. Atmospheric opacity versus wavelength



BAREME (Remarque : des points pour « present the documents and / or enlarge » sont prévus car les élèves ont le réflexe de le faire puisque cela leur est demandé à l'oral dans l'académie.)

Present the documents or enlarge	1.5				
What is Planck ? Satellite / European / launched in 2009 / deactivated in 2013 (doc 1)	0.5				
Designed to map the sky (doc 2) / inf'n on the U. as it was ≈ 4.10^5 yrs after B.B. (doc3)	0.5				
CMB U. at that time ≈ constant black body (doc 4)	0.5				
E..M. waves (µwaves doc exercise 1-e !)	0.5				
Entire sky (doc 3) / evenly spread over the sky (doc 5) / almost constant b.b. (doc 4)	0.5				
Wavelength T = 3K → λ = 1 mm→between IR & radiowaves (doc 6) (Rem : µwaves says ex1-e)	1.5				
Absorbed by atm. gases (doc 6) → space observatory	1				
Conclusion information about the U. as it was ≈ 4.10^5 yrs after B.B. / fluctuation → map	1				
Neatness / language accuracy	1.5				
	9				

Discuss : is this a wave ? yes or no because… (0.5) mechanical (0.5) / DISCUSS (1)	2				
DISCUSS… second try ! (extra 1.5)					
Match the words (-0.5)/mistake (ex : "Grills use radio waves to cook")	1.5				
E.M. stands for ElectroMagnetic	0.5				
Optical fiber sketch / 6 lines	1				
at least 4 of these : reflection, refraction, refracting index, total internal reflexion, cladding	2				
Fill the blanks (-0.5)/mistake	1				
Your presentation it was about… 5 lines	2.5				
Neatness / language accuracy	0.5				
	11				