

Captains' fight

Captains' fight n°1 : Question

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You have **3 minutes** to answer the following question :

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Gravitational waves were discovered thanks to a collision of two supermassive blackholes of about $30M_{\odot}$, 1 billion lightyears away from Earth. Estimate the amount of energy *in joules* received on Earth.

Captains' fight n°1 : Answer

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- It was measured that $3M_{\odot}$ was emitted (an estimate that students can think of would be 1% of the total masses). The corresponding energy is

$$\mathcal{E} = mc^2 = 3 \times 1,9 \cdot 10^{30} \times (3 \cdot 10^8)^2 = 5,1 \cdot 10^{47} \text{ J} \quad (1)$$

- We suppose the energy distributed equally on a sphere of radius $R = 10^9$ lightyears or $R = 10^9 \times 9,5 \cdot 10^{15} \text{ m} = 9,5 \cdot 10^{24} \text{ m}$. The radius of Earth being $R_T = 6400 \text{ km} = 6,4 \cdot 10^6 \text{ m}$, the amount of energy that arrives on Earth is

$$\mathcal{E}_{\text{Earth}} = \frac{R_T^2}{R^2} \mathcal{E} = \frac{41 \cdot 10^{12}}{10^{50}} \times 5,1 \cdot 10^{47} \quad (2)$$

Finally

$$\boxed{\mathcal{E}_{\text{Earth}} = 2,1 \cdot 10^{11} \text{ J}} \quad (\log_{10} \mathcal{E}_{\text{Earth}} = 11.32) \quad (3)$$

You want more?

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Really?

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Quick : 1min

Question : How many orders of magnitude are there between the highest and lowest artificially obtained temperatures ?

You want more ?

Really ?

Quick : 1min

Question : How many orders of magnitude are there between the highest and lowest artificially obtained temperatures ? **Answer**

- ▶ Hottest temperature : quark and gluon plasma at LHC :
 5×10^{12} K
- ▶ Lowest temperature : adiabatic demagnetization : 5×10^{-10} K
- ▶ Thus : 22 orders of magnitude.