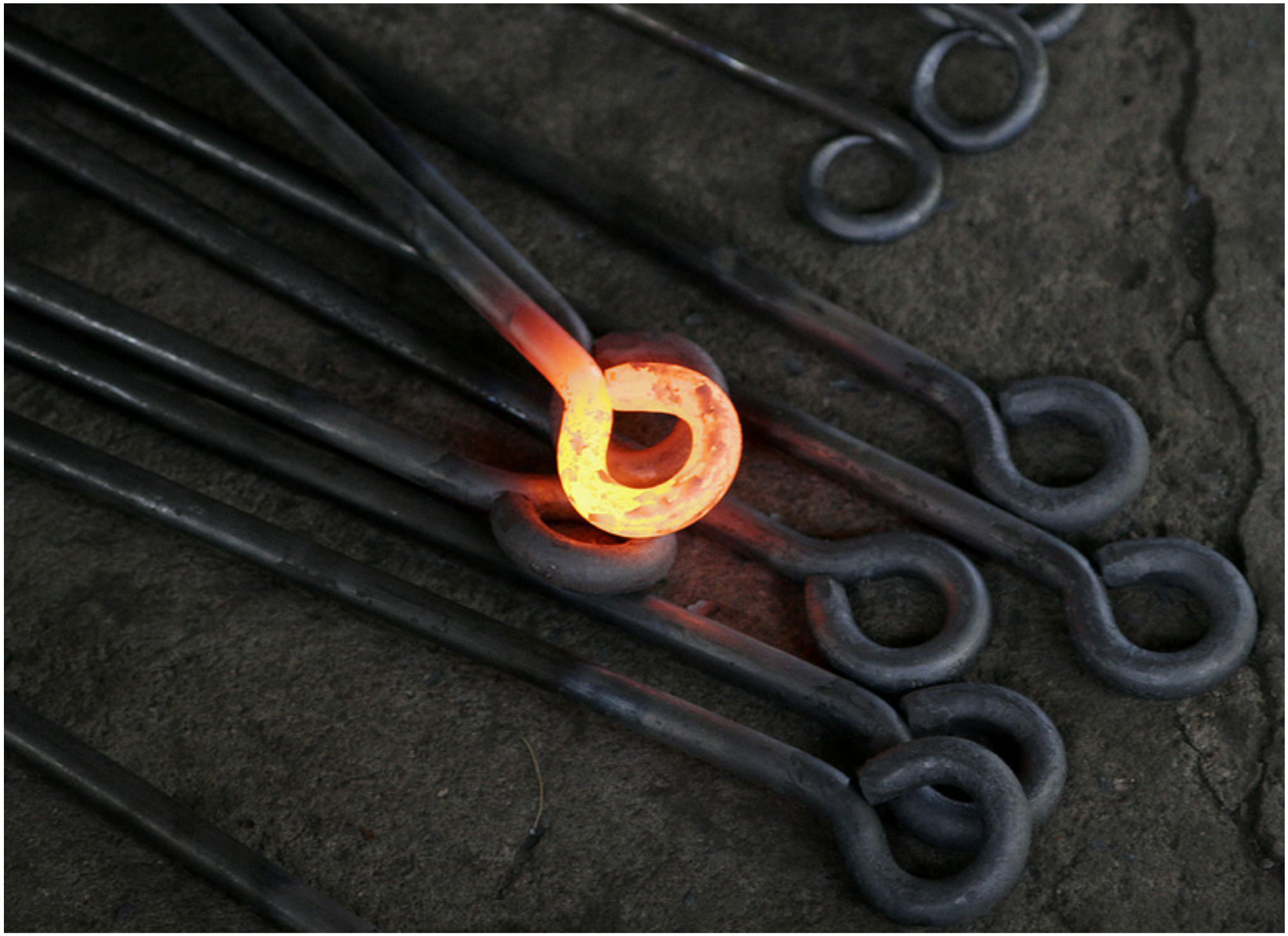
Rayonnement d'équilibre thermique. Corps noir

Niveau : L3

Prérequis :

- Modes de transferts thermiques : rayonnement
- Notion d'onde électromagnétique
- Notion de flux
- Physique statistique : densité d'états, gaz de photons, nombre d'occupation, statistique de Bose-Einstein

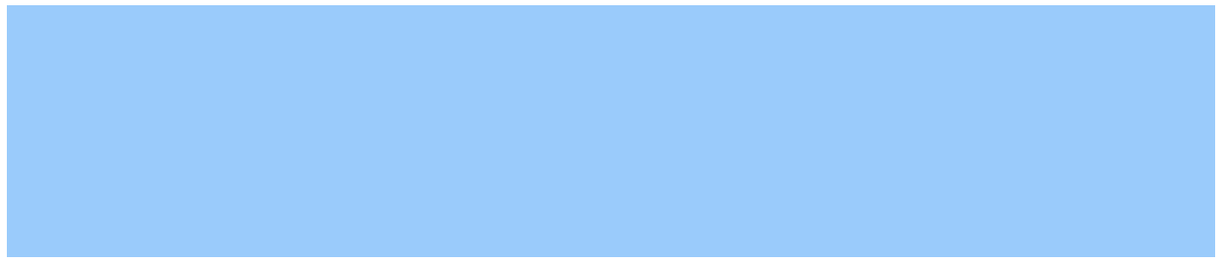
Introduction



Source : Wikipédia, Par fir0002flagstaffotos

I.2) Interaction rayonnement matière

<u>Flux</u> : puissance électromagnétique transmise au corps, noté ϕ, exprimé en Watts.



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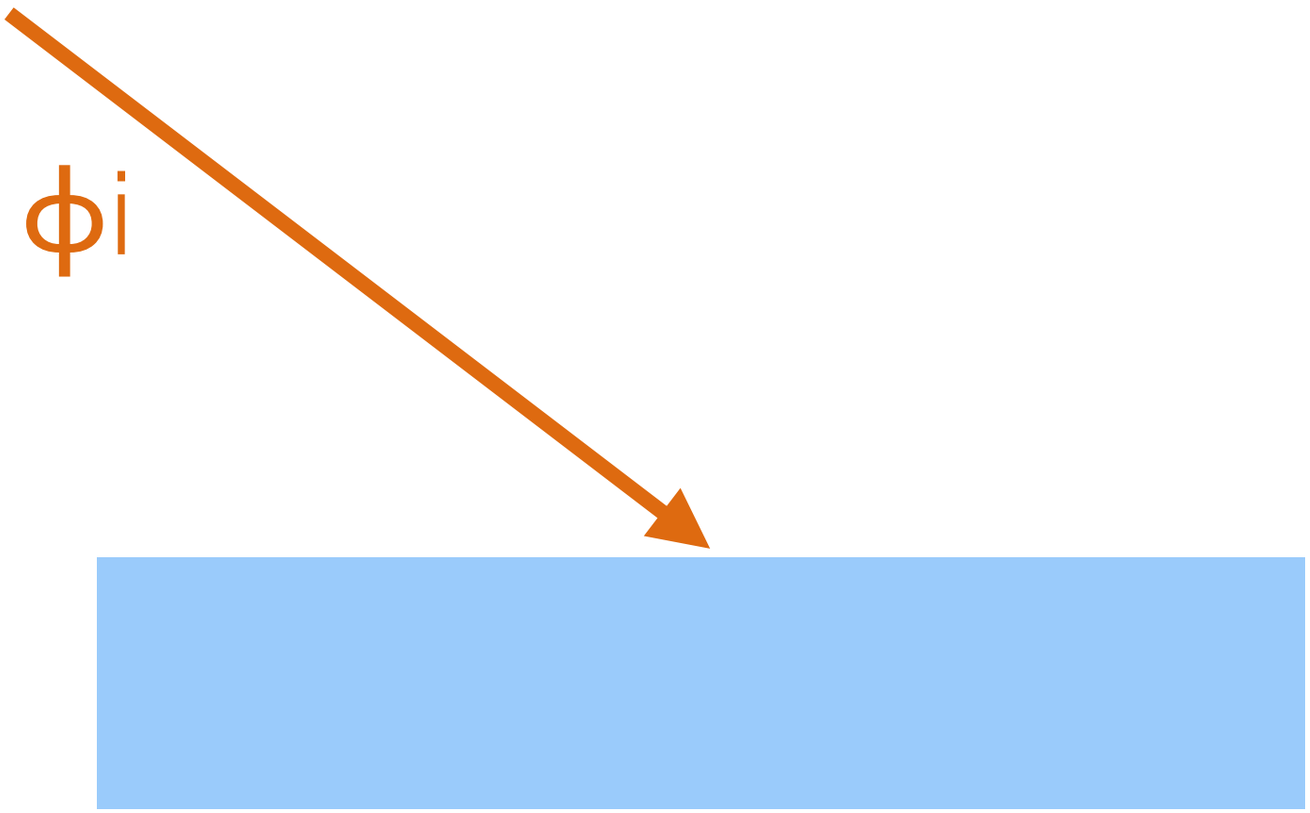

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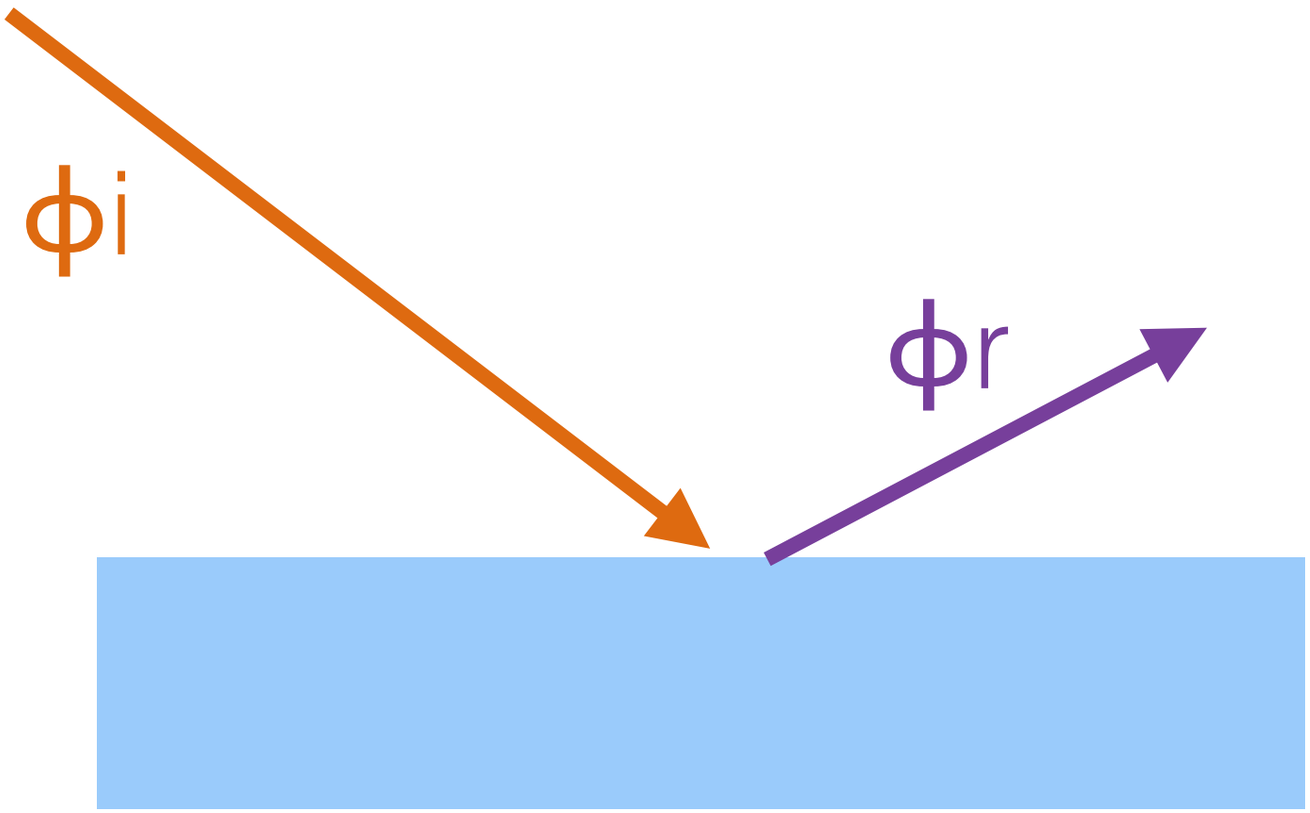

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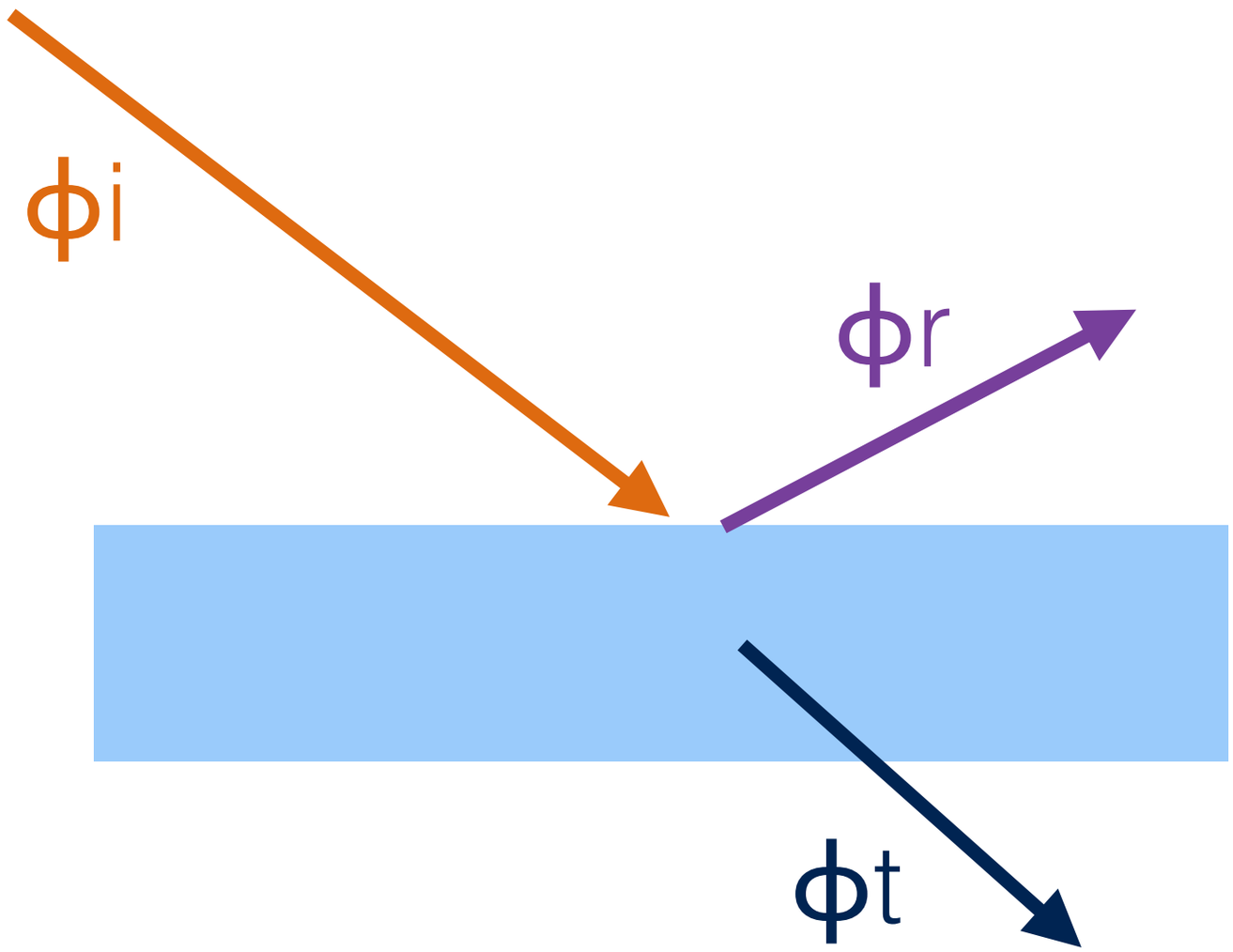

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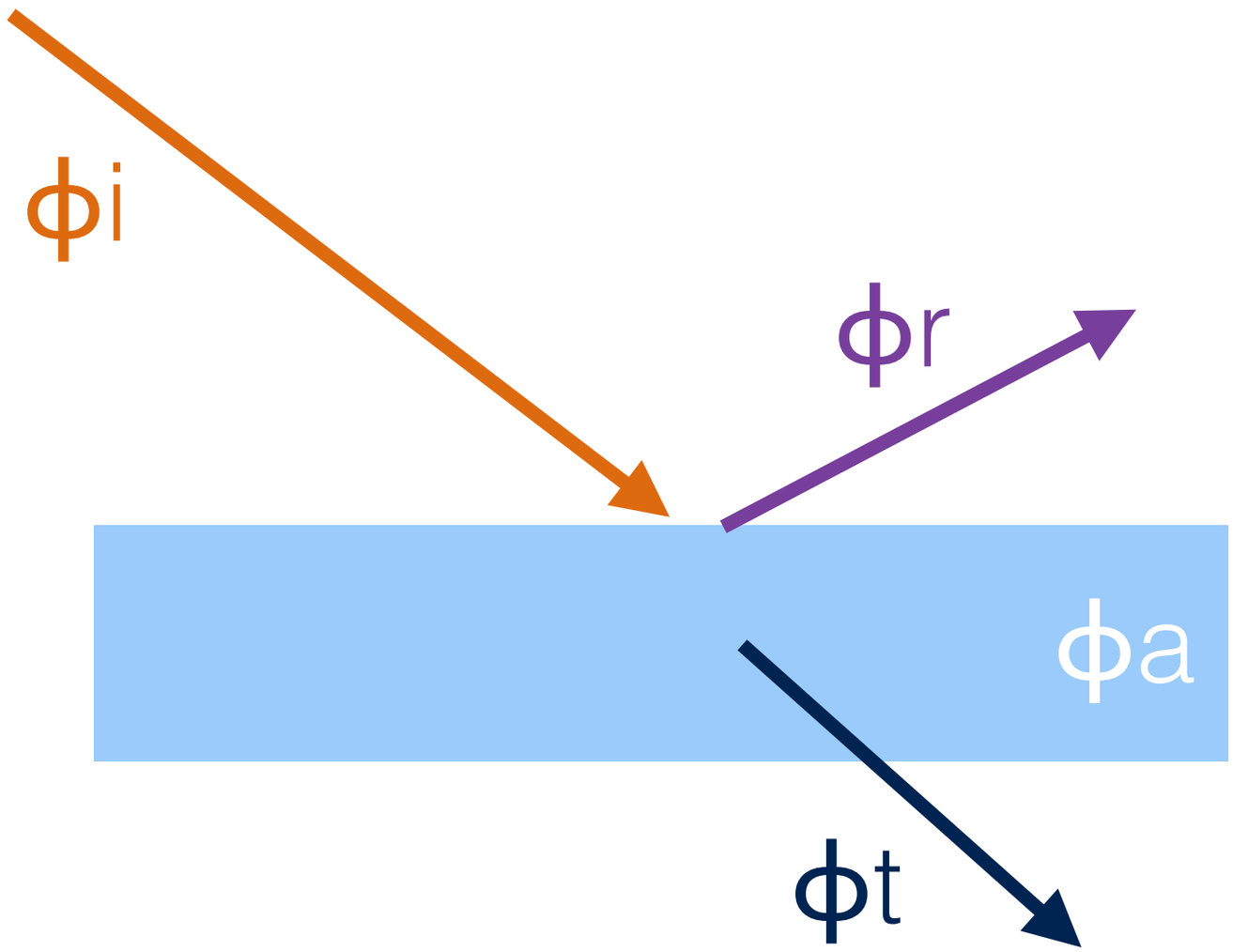
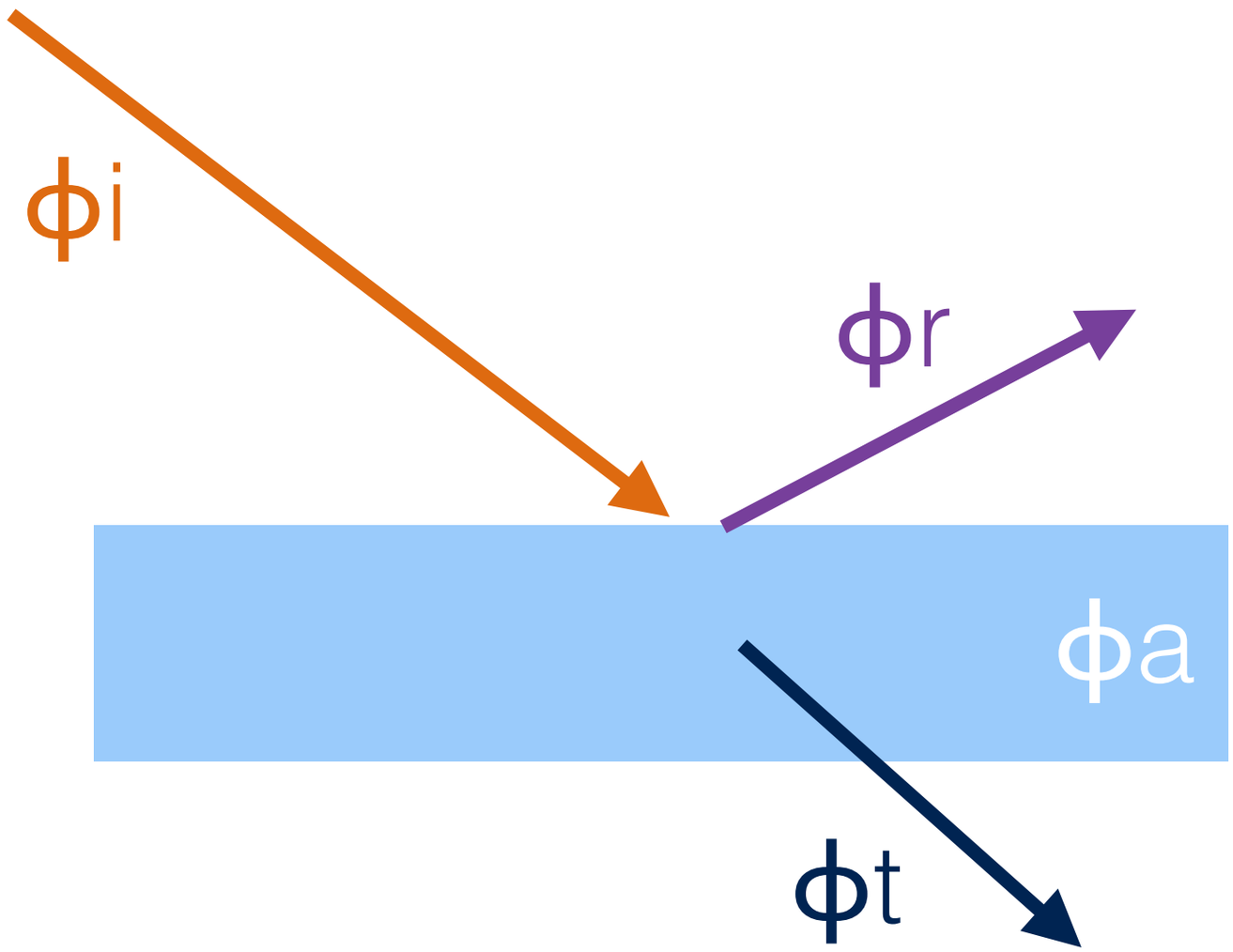


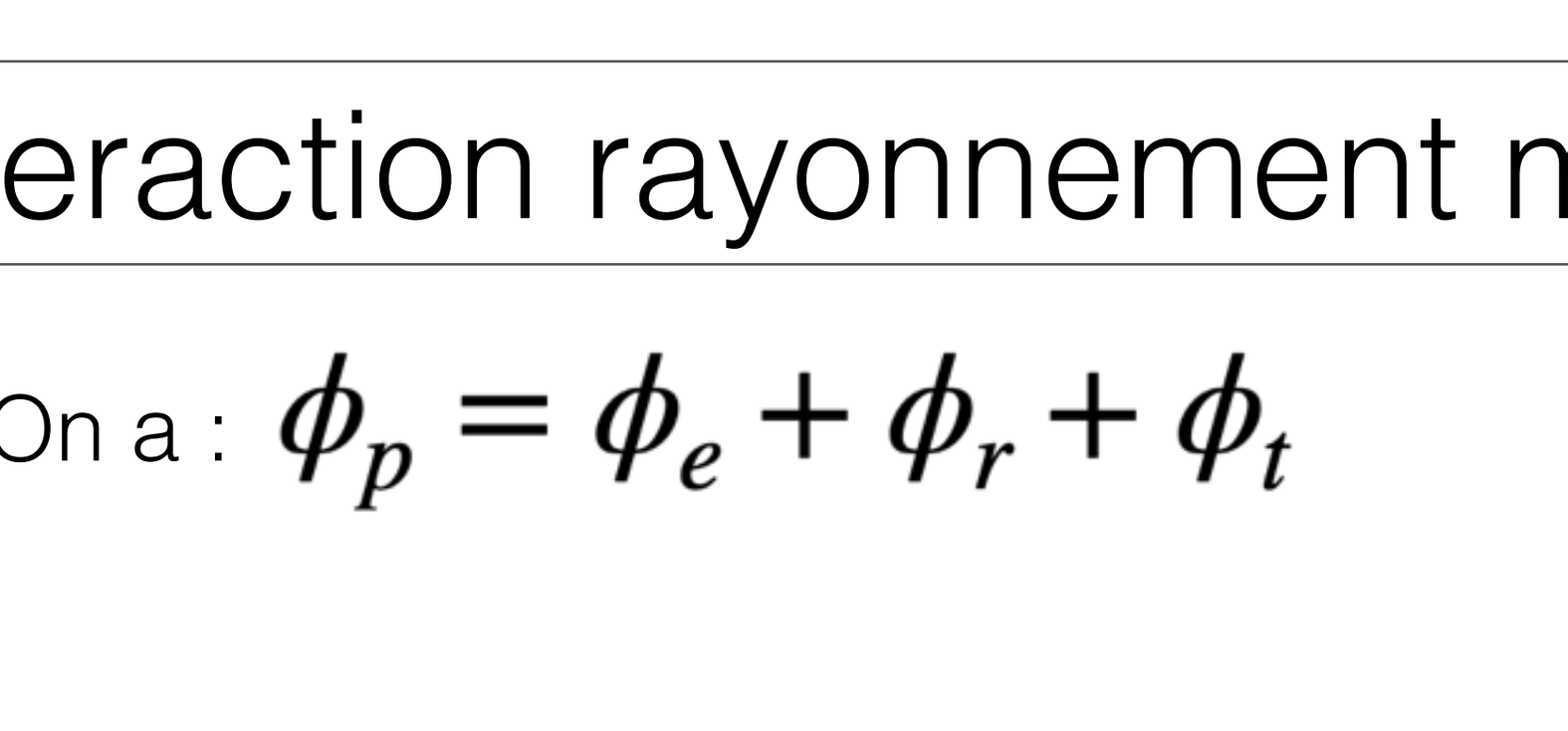
I.2) Interaction rayonnement matière

On a : $\phi_i = \phi_r + \phi_a + \phi_t$



I.2) Interaction rayonnement matière

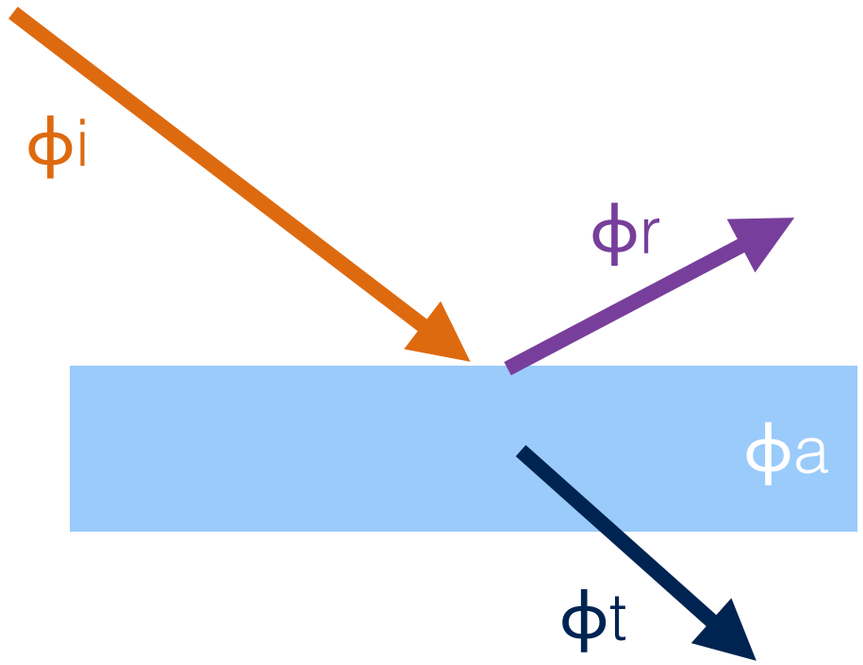
On a : $\phi_p = \phi_e + \phi_r + \phi_t$



II.2) Interaction rayonnement matière

On définit le flux radiatif :

$$\phi_R = \phi_e - \phi_a = \phi_p - \phi_i$$



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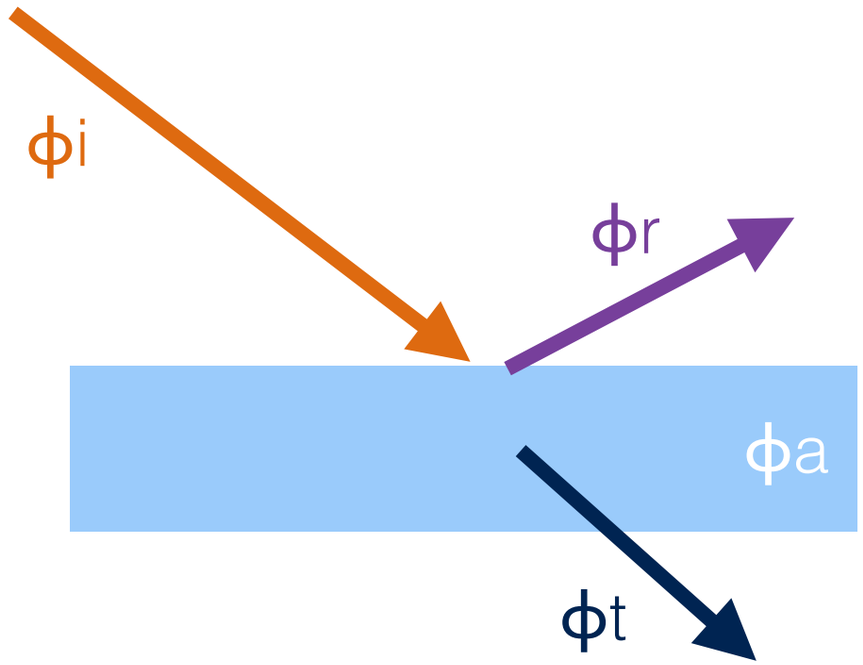

Cas limites :

- Si : $\phi_a = \phi_r = 0$ alors $\phi_i = \phi_t$: parfaitement transparent

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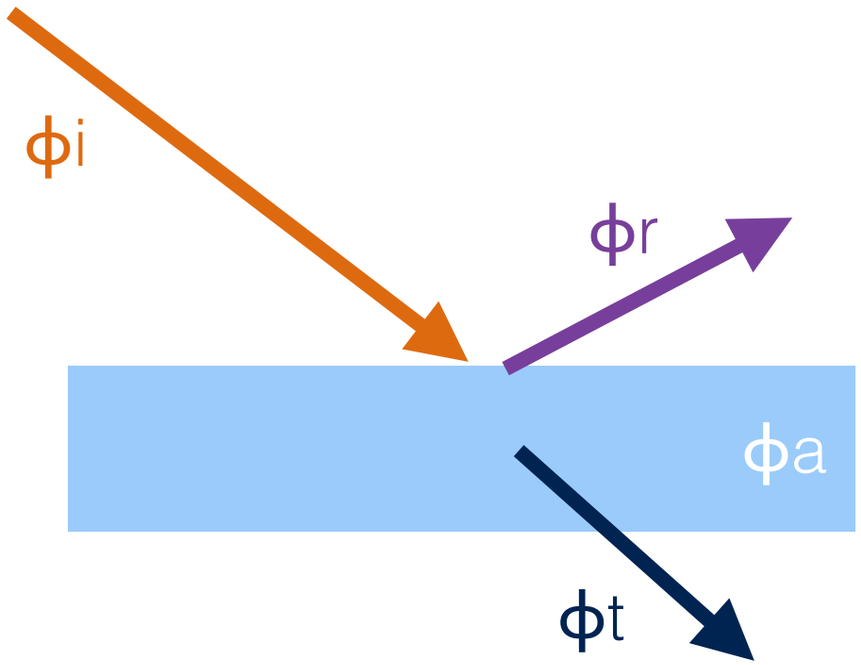

Cas limites :

- Si : $\phi_a = \phi_r = 0$ alors $\phi_i = \phi_t$: parfaitement transparent
- Si : $\phi_a = \phi_t = 0$ alors $\phi_i = \phi_r$: parfaitement réfléchissant

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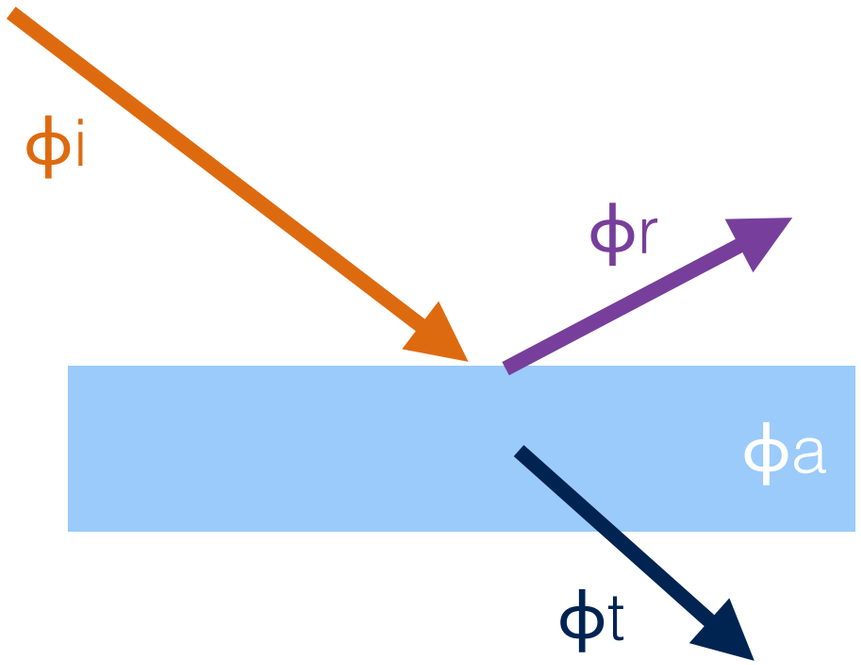
On définit le flux radiatif :

$$\phi_R = \phi_e - \phi_a = \phi_p - \phi_i$$



Cas limites :

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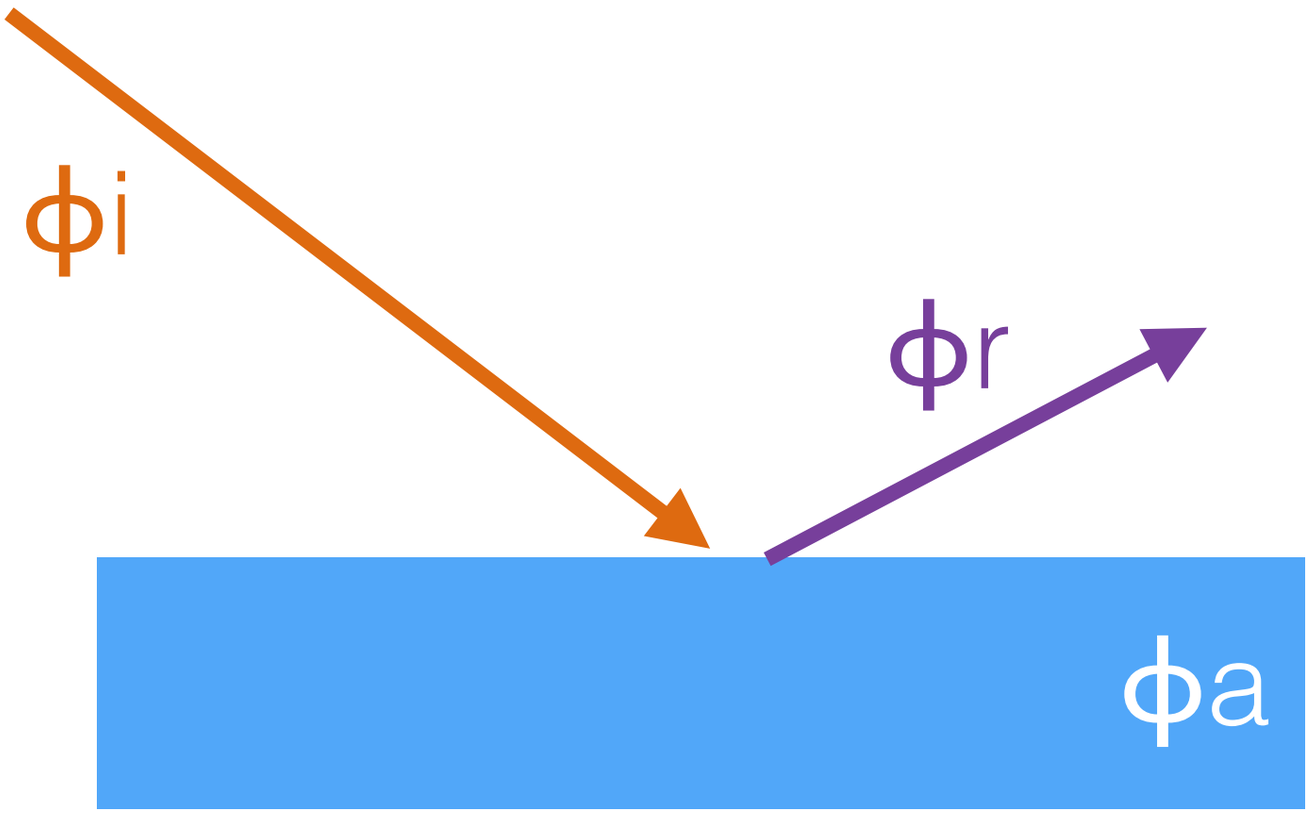
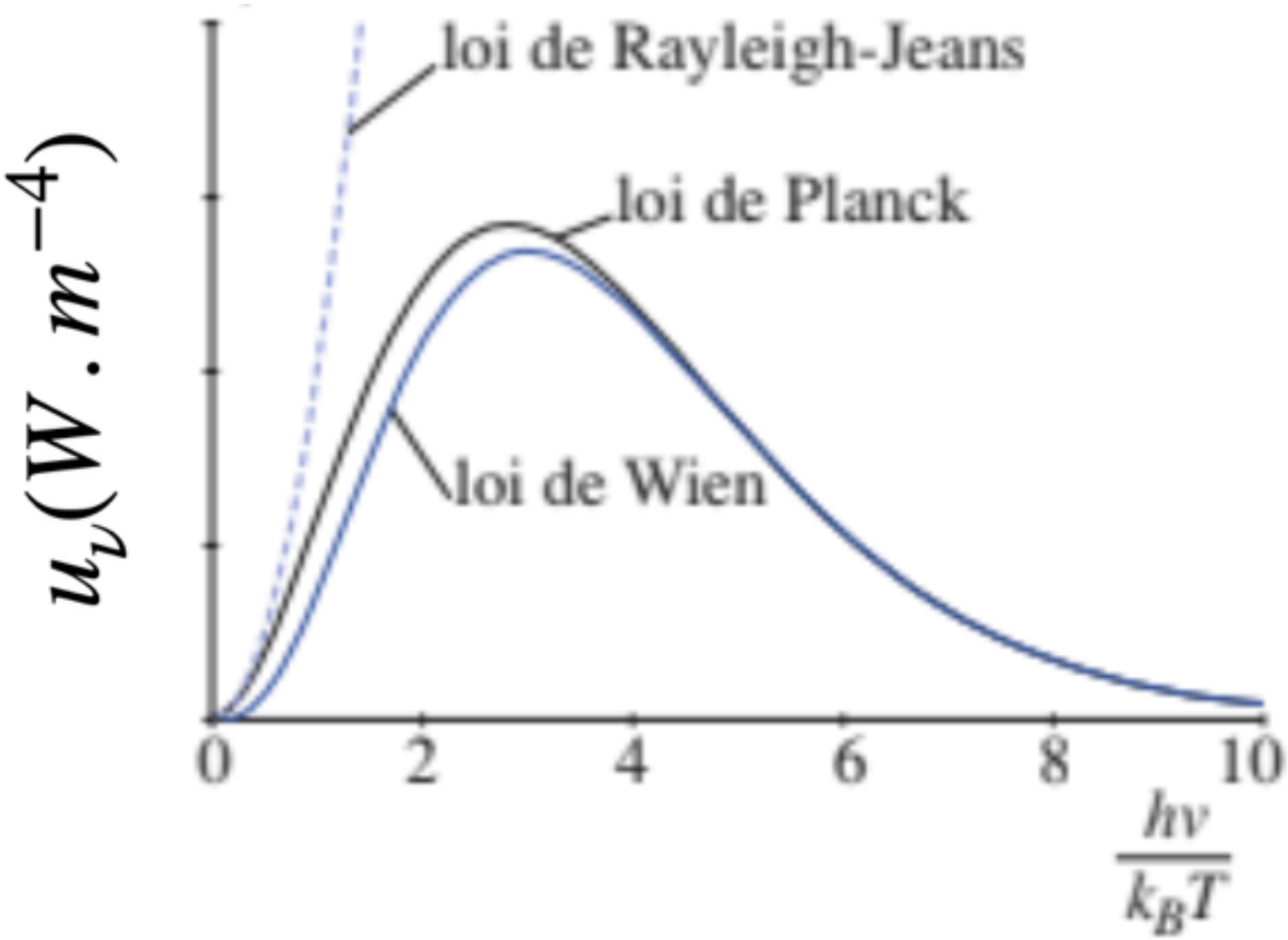
- Si : $\phi_a = \phi_t = 0$ alors $\phi_i = \phi_r$: parfaitement réfléchissant
- Si : $\phi_t = \phi_r = 0$ alors $\phi_i = \phi_a$: parfaitement absorbant

II.2) Interaction rayonnement matière

Pour un corps opaque : $\phi_t = 0$



I.3) Loi de Planck



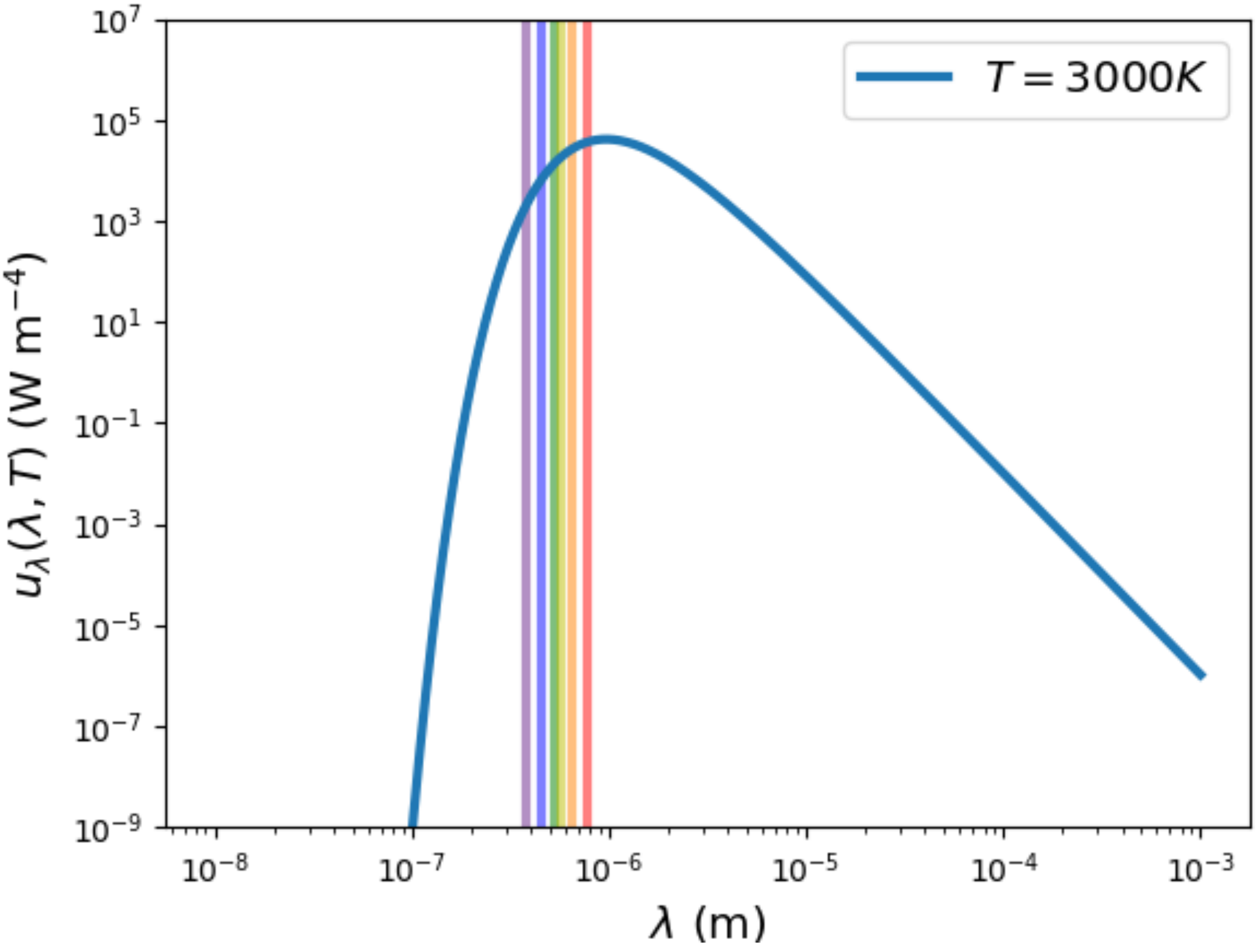
Source : H-Prépa, Thermodynamique

Densité spectrale d'énergie

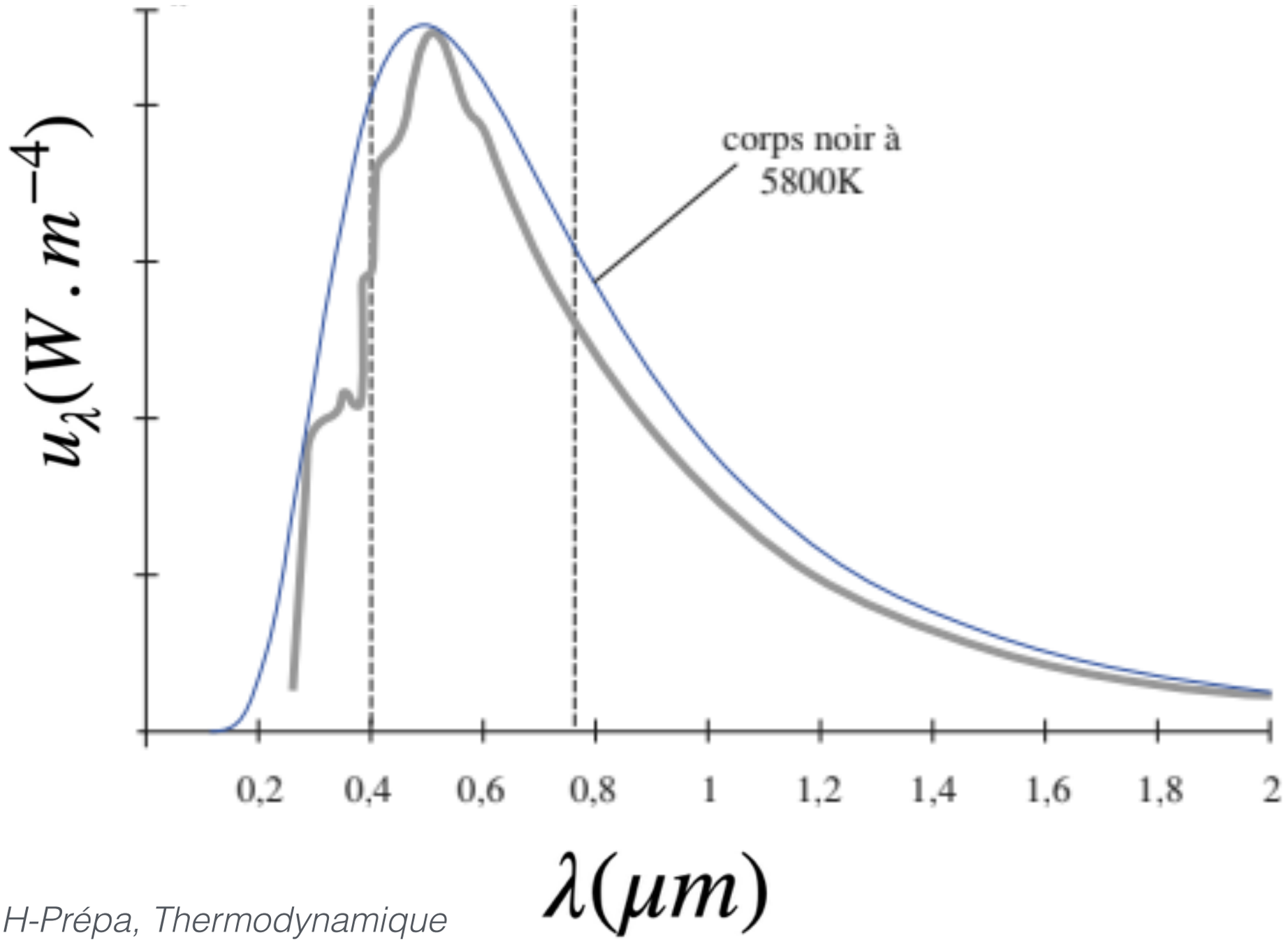
- U : énergie totale
- u : énergie par unité de volume
- du : densité volumique d'énergie dans une bande de fréquence entre ν et ν+dν

Alors : $$du = u_\nu(\nu, T)d\nu$$

I.3) Loi de Planck



I.4) Spectre du Soleil



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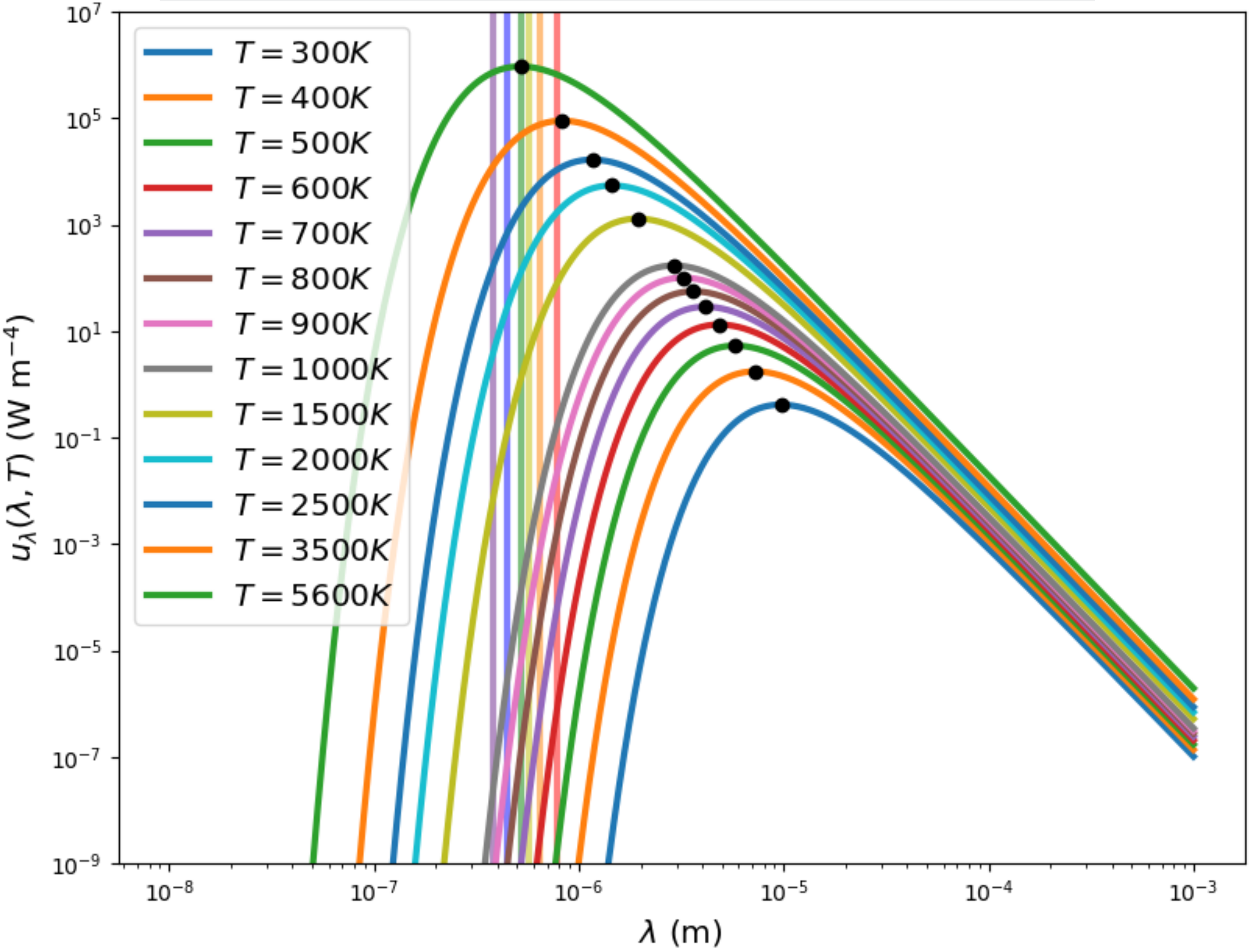
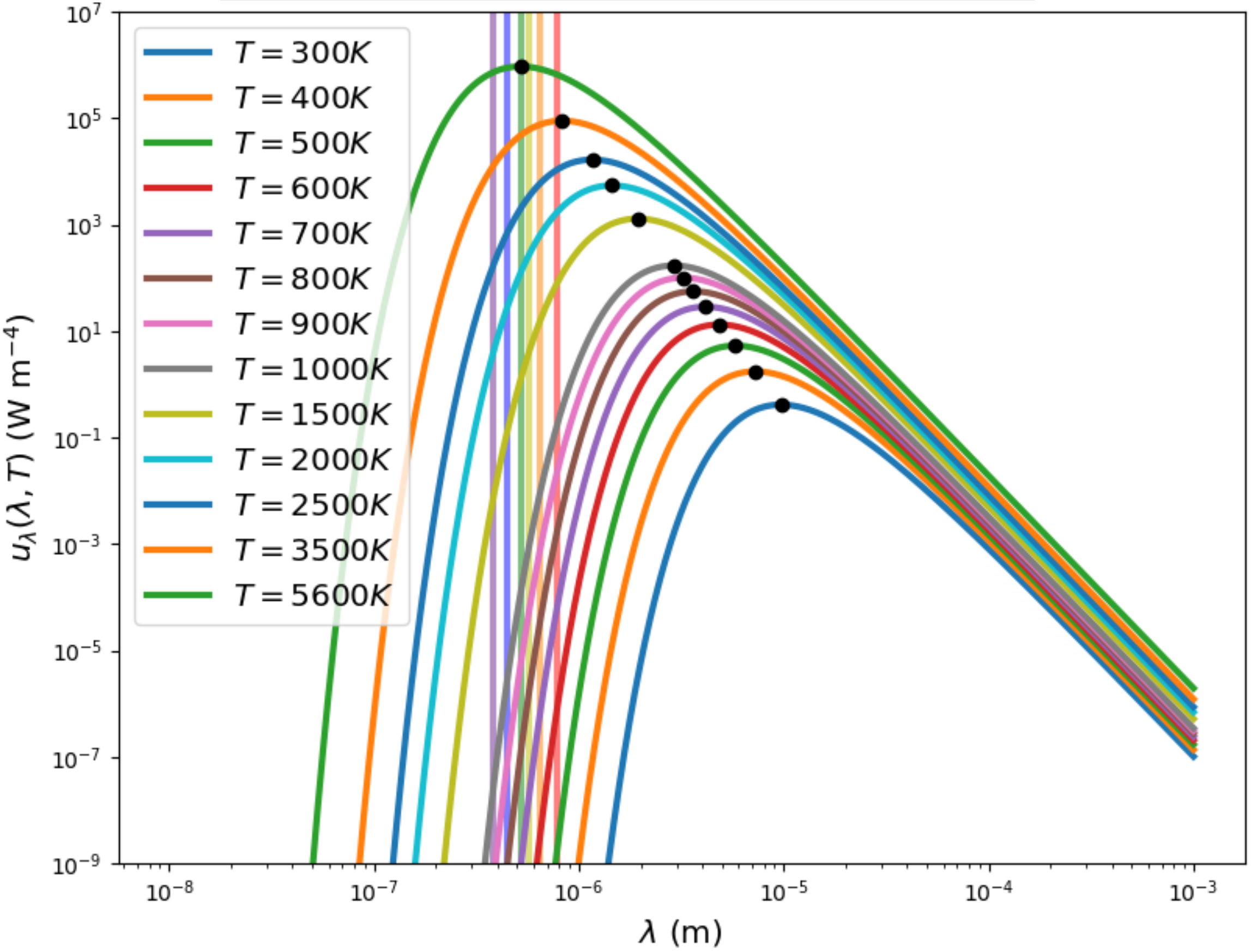
II.1) Loi de déplacement de Wien



II.2) Loi de Stefan-Boltzmann

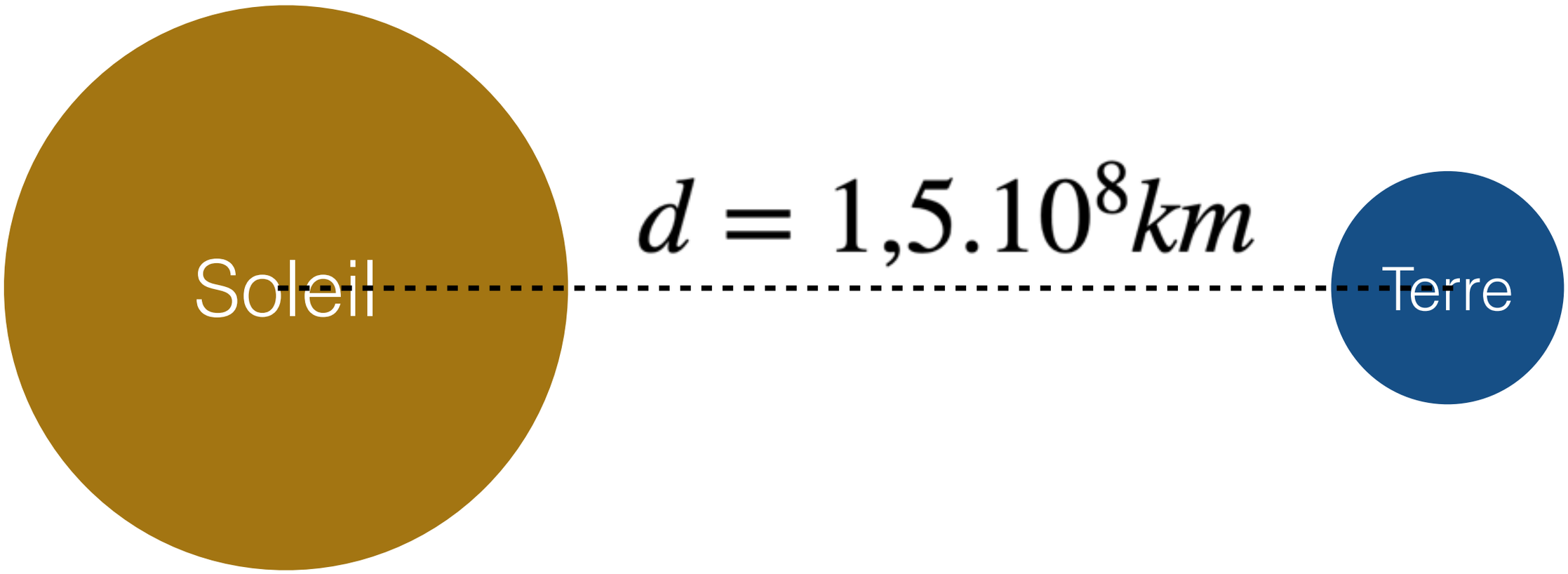


II.3) Application : Température de surface de la Terre

$R_S = 7.10^5 km$

$T_S = 5800K$

$R_T = 6400km$



Le schéma n'est pas à l'échelle

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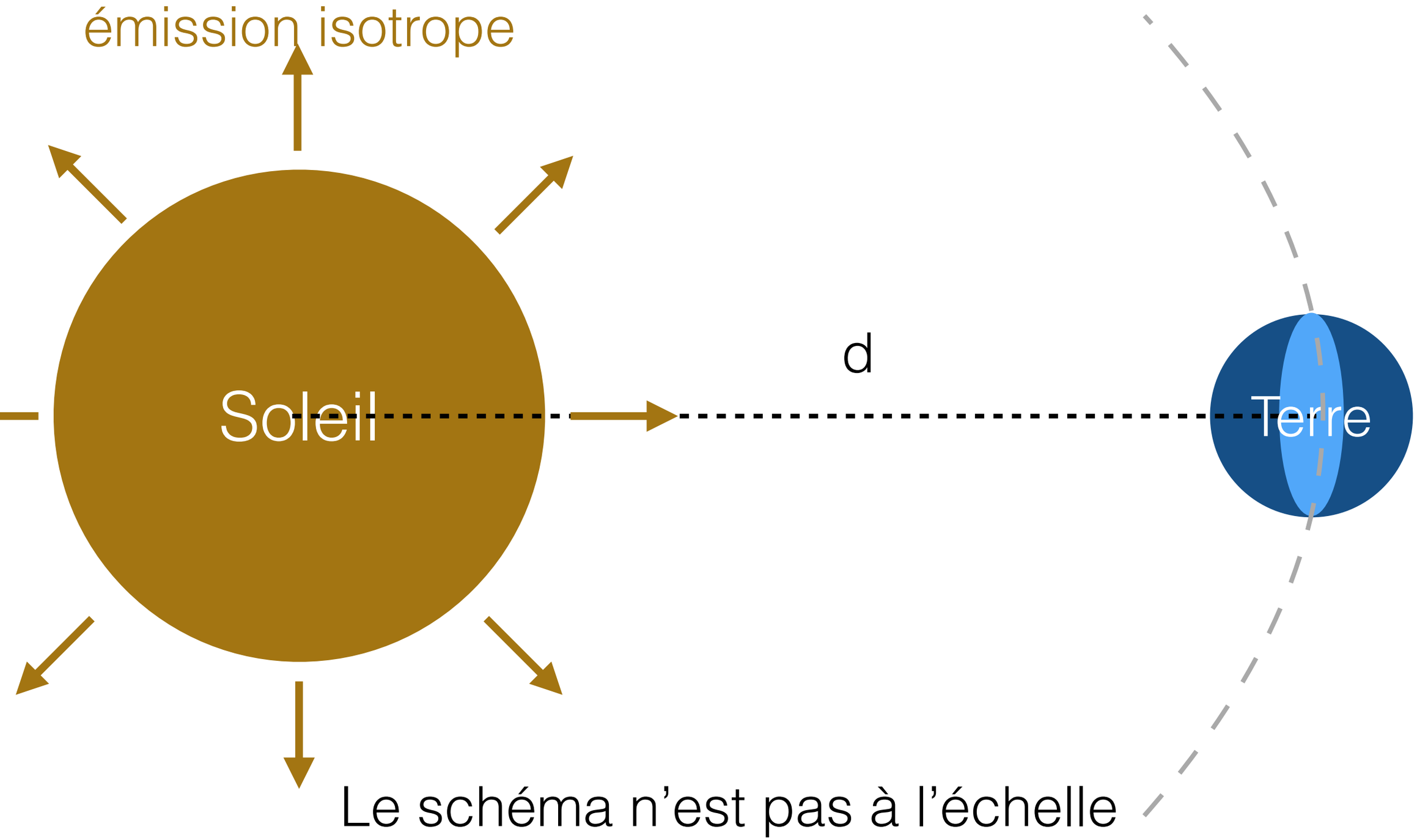

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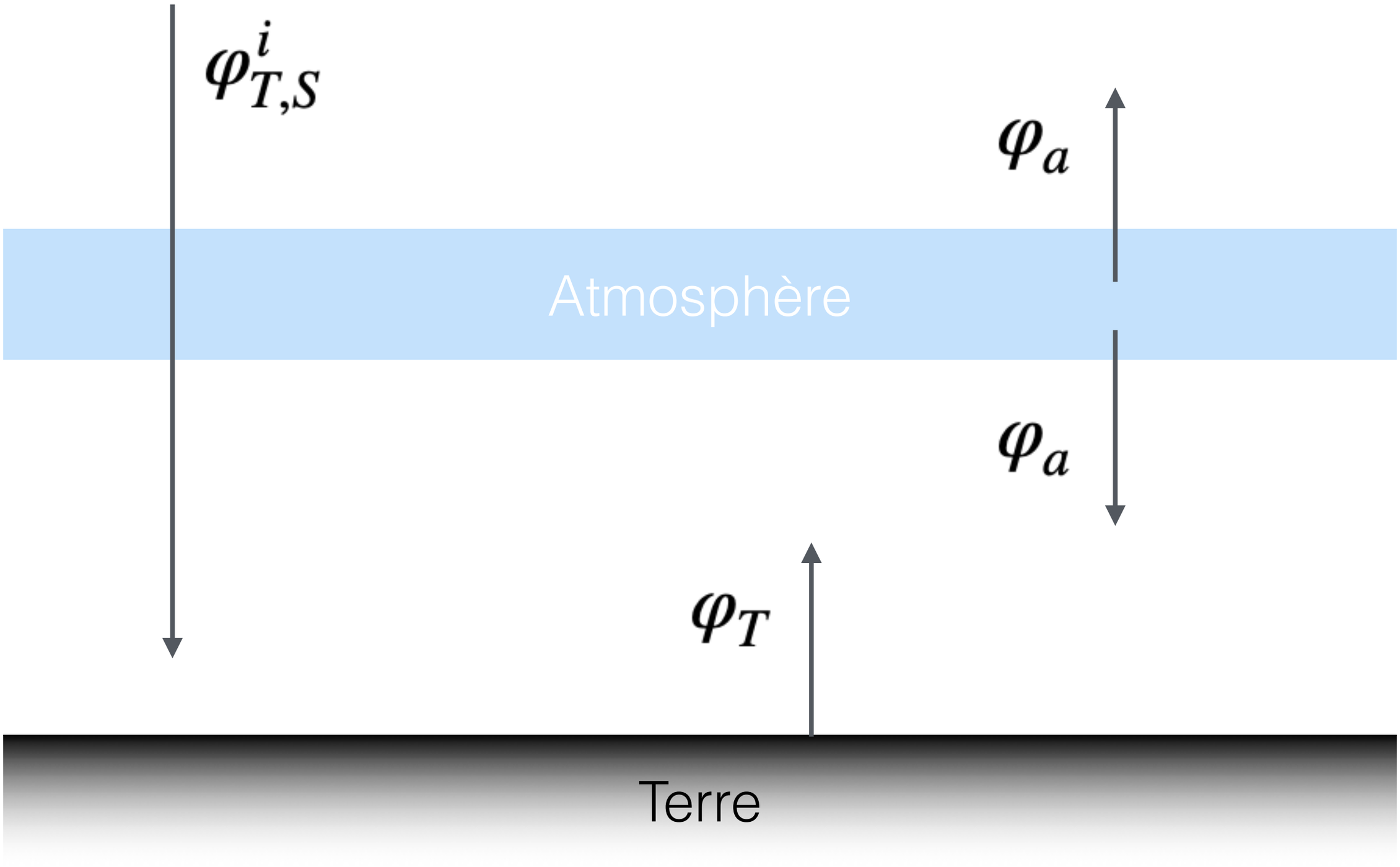

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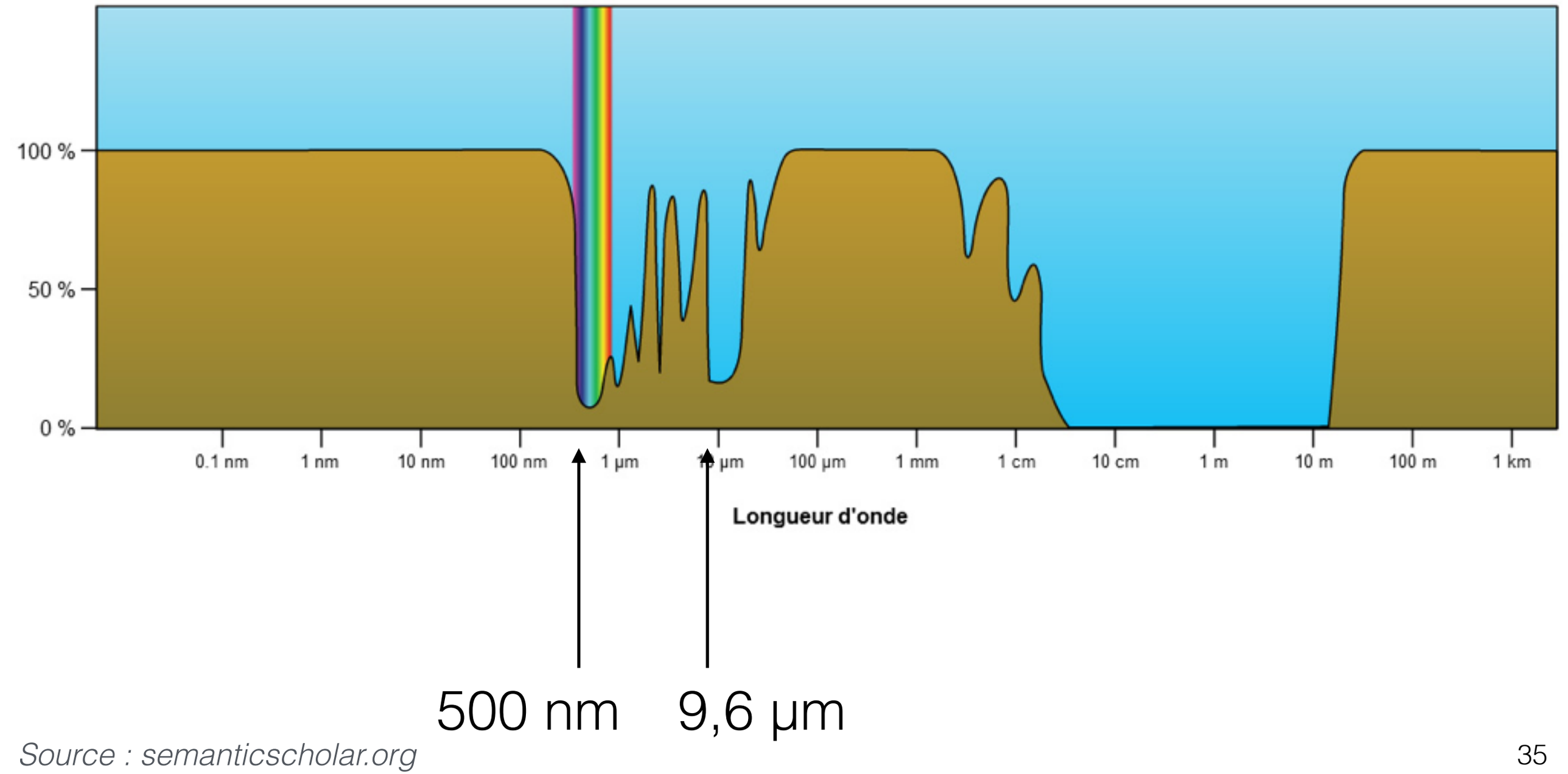

Source : semanticscholar.org