

2023年ノーベル物理学賞解説

藤間 崇 (Takashi Toma)

国際基幹教育院 (Institute of Liberal Arts and Science)

2023年のノーベル物理学賞



Ill. Niklas Elmehed © Nobel Prize Outreach

Pierre Agostini

Prize share: 1/3



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Anne L'Huillier

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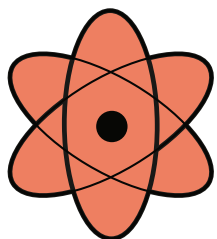
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2023年のノーベル物理学賞

- 物質中の電子運動の研究のための
アト秒パルス光を生成する実験方法の開発

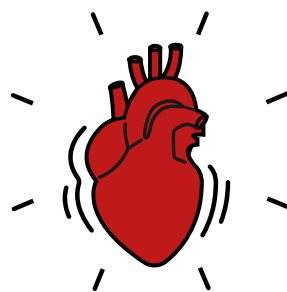
- アト = 10^{-18}

光： $3.0 \times 10^8 \text{ m/s} \Rightarrow$ 1アト秒中に $3.0 \times 10^{-10} \text{ m}$ しか進まない



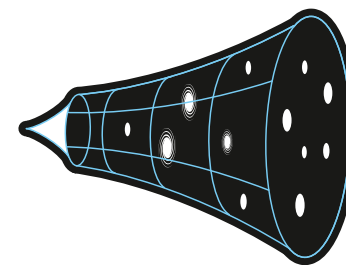
ATTOSECOND

$1/1,000,000,000,000,000,000$
SECOND



HEARTBEAT

1 SECOND



AGE OF THE UNIVERSE

$1,000,000,000,000,000,000$
SECONDS

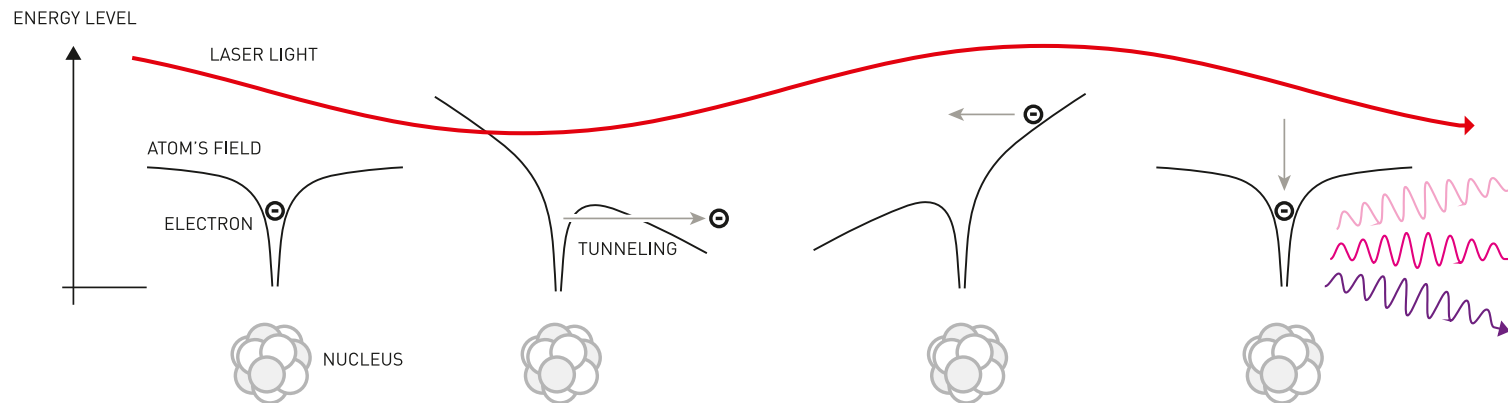
Electrons' movements in atoms and molecules are so rapid that they are measured in attoseconds. An attosecond is to one second as one second is to the age of the universe.

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2023年のノーベル物理学賞

- レーザーを希ガスに当てると、電子を束縛している原子核の位置エネルギーの形が変化する
- 電子が「トンネル効果」を通じて動く
⇒ 電子の余分なエネルギーをパルス光として外に出す



1 An electron that is bound to an atom's nucleus cannot normally leave its atom; it does not have enough energy to lift itself out of the well created by the atom's electrical field.

2 The atom's field is distorted when it is affected by the laser pulse. When the electron is only held by a narrow barrier, quantum mechanics allow it to tunnel out and escape.

3 The free electron is still affected by the laser field and gains some extra energy. When the field turns and changes direction, the electron is pulled back in the direction it came from.

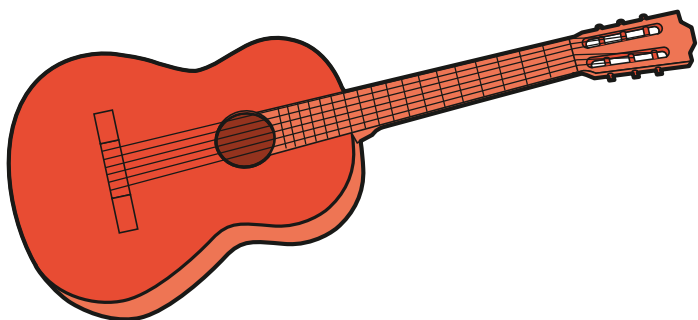
4 To reattach to the atom's nucleus, the electron must rid itself of the extra energy it gained during its journey. This is emitted as an ultraviolet flash, the wavelength of which is linked to that of the laser field, and differs depending on how far the electron moved.

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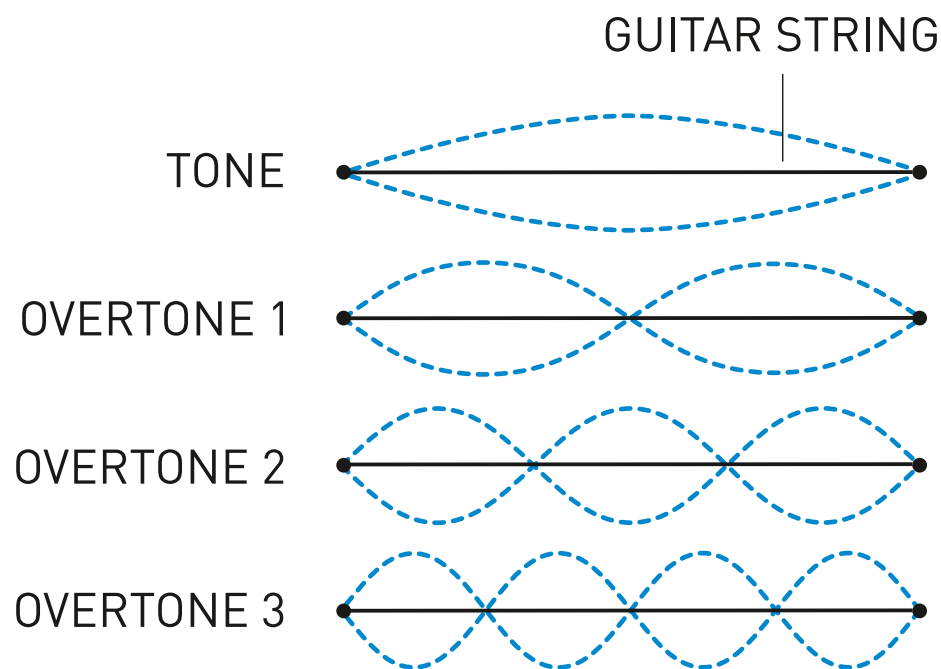
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2023年のノーベル物理学賞

- 光も音波も波動で記述される
- ギターの弦を弾くといくつかの倍音が出る
- 定常波 ⇒ 第5回目にて



Overtone has several cycles for each cycle in the fundamental tone. Overtone works the same way in light waves.



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2023年のノーベル物理学賞

- いくつかの倍音が干渉する \Rightarrow パルス光を作る
- 素早く運動する電子を観察することが可能になる

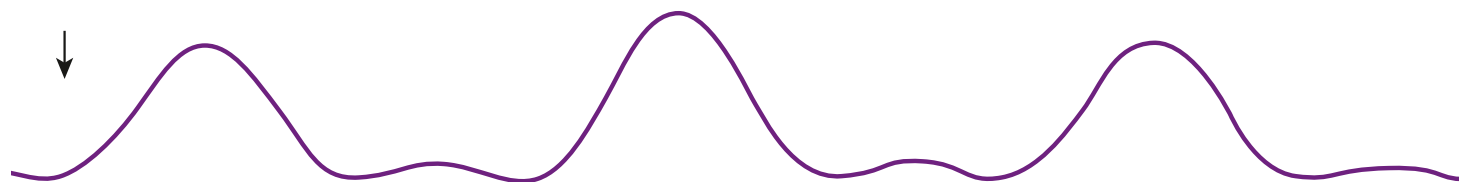
OVERTONES ARE
SUPERIMPOSED



REINFORCE OR CANCEL
EACH OTHER



ATTOSECOND PULSES



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