

Invisible Forces

Redux

Jess H. Brewer

Etymology:

force (n.)

c. 1300, “physical strength,” from Old French *force* “force, strength; courage, fortitude; violence, power, compulsion” (12c.), from Vulgar Latin **fortia* (source also of Old Spanish *forzo*, Spanish *fuerza*, Italian *forza*), noun use of neuter plural of Latin *fortis* “strong, mighty; firm, steadfast; brave, bold” (see [fort](#)).

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Related: *Forces*.

Standard Model “forces”

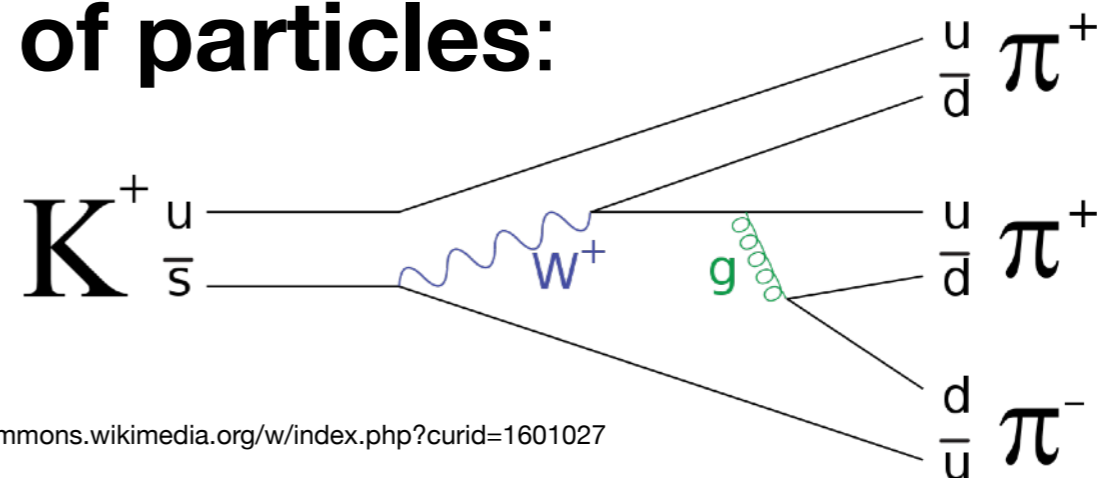


Standard Model

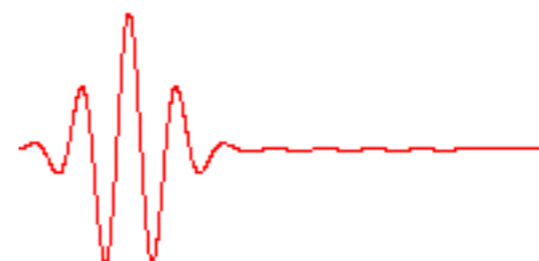
“forces”

* *Mediated by exchange of particles:*

- Feynman Diagrams like

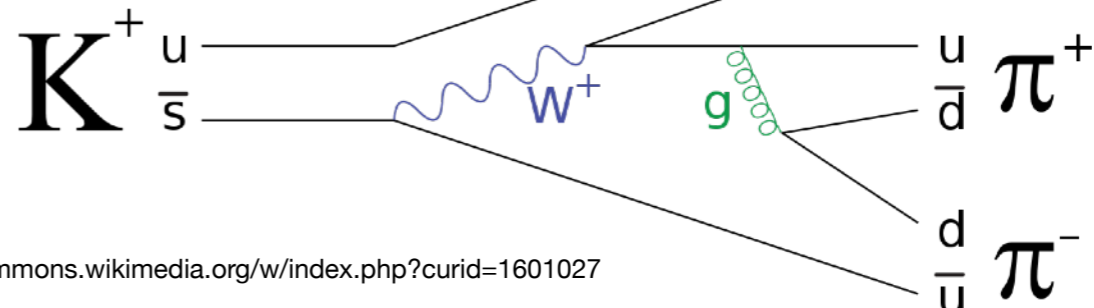


By JabberWok, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=1601027>



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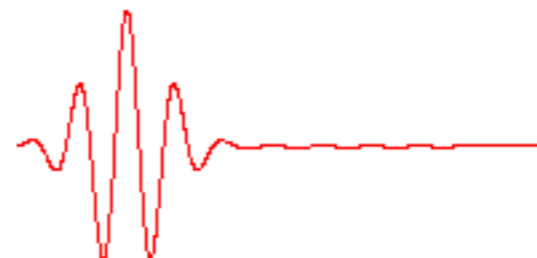
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The diagram shows a K^+ meson (composed of u and \bar{s} quarks) decaying into three pions (π^+ , π^+ , and π^-). The decay is mediated by a W^+ boson (represented by a blue wavy line) and a gluon (g , represented by a green curly line). The W^+ boson decays into a u quark and a \bar{d} quark, which form a π^+ meson. The gluon then splits into a d quark and a \bar{u} quark, which form a π^- meson. The remaining u quark from the W^+ decay and the original \bar{s} quark from the K^+ meson form another π^+ meson.

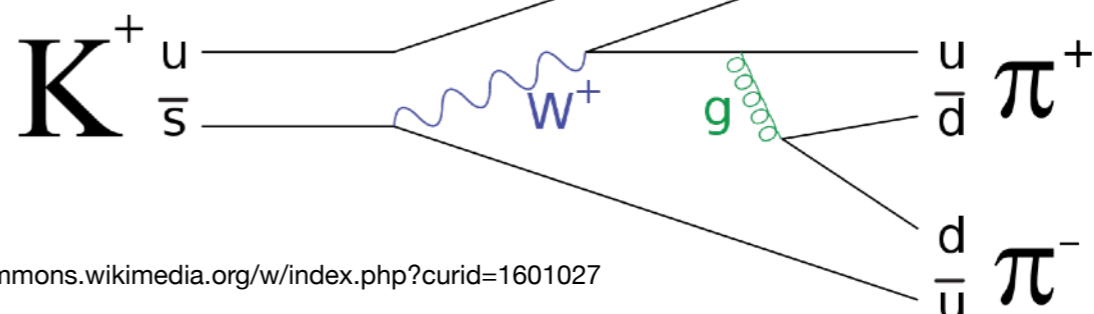
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- Too *Small* to see! (diameter \ll wavelength of light)



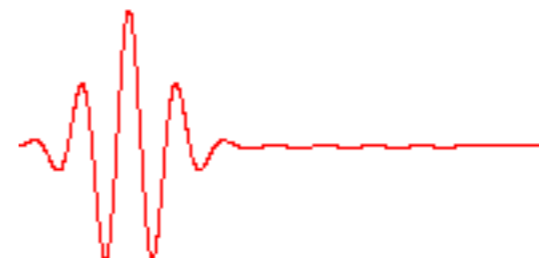
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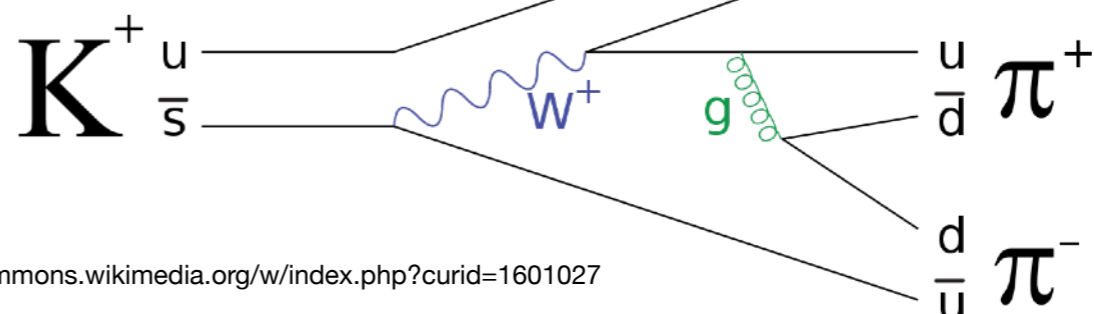
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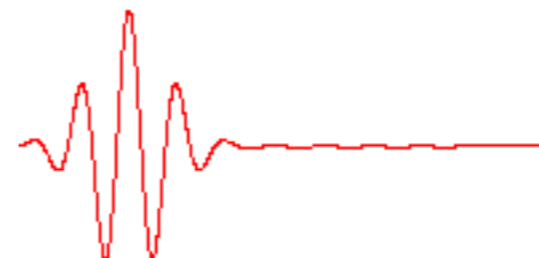
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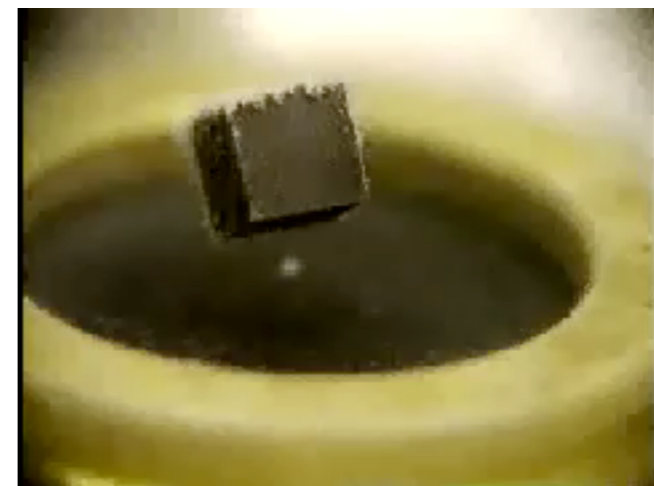
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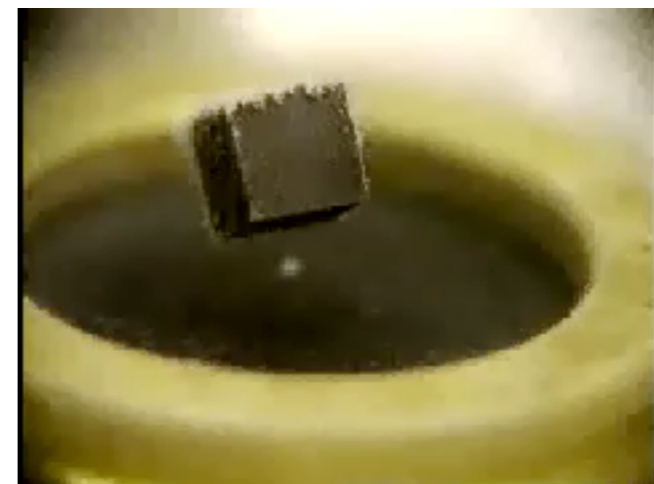


Familiar(?) Examples that still seem Magical



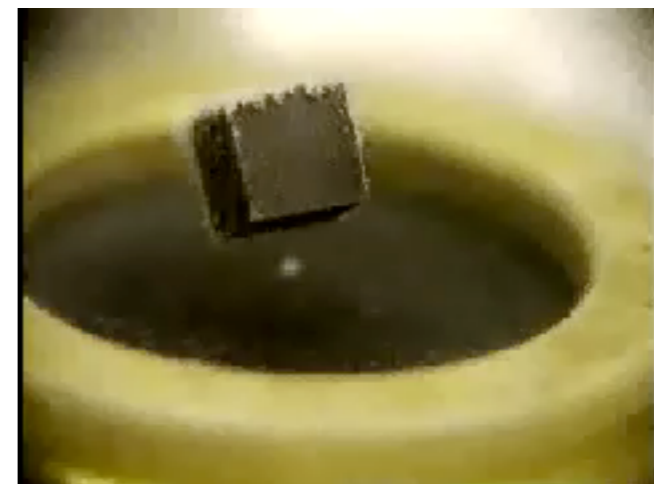
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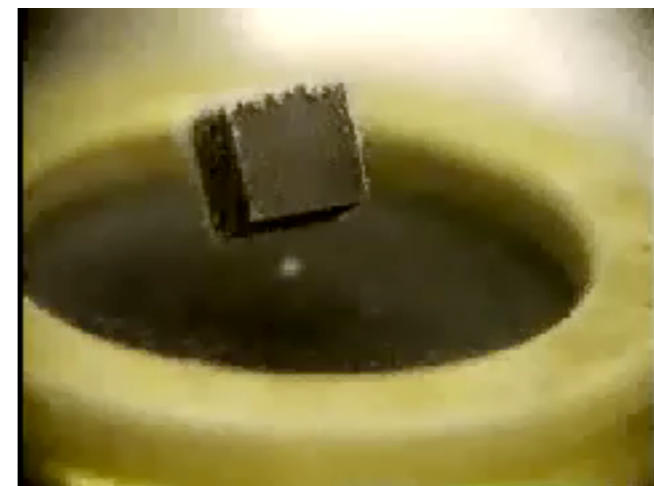
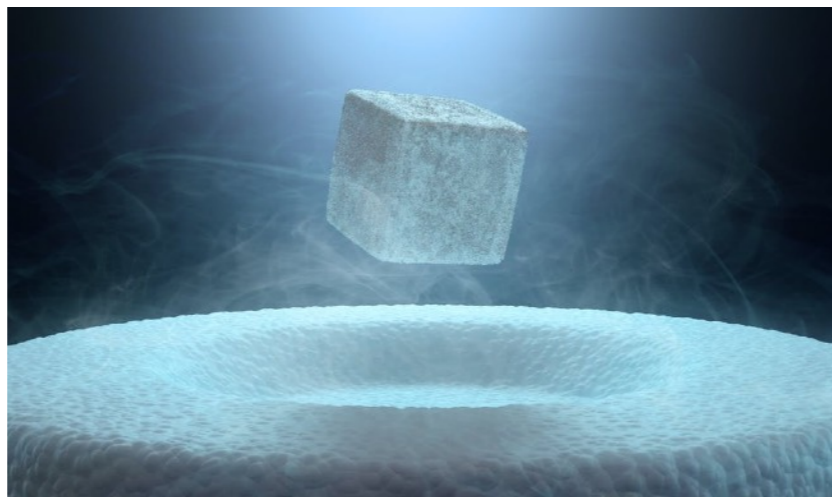
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Familiar(?) Examples that still seem Magical

- After use in dry air, a *hairbrush* will pick up bits of *lint*.
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- Magnetic levitation of (or *by*) a *superconductor*.



Some “Visible” Forces

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- Pushing against a person with your hand.

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- Pushing against a person with your hand.
- The ground pushing up on your feet.

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- The ground pushing up on your feet.
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- A boat floated by the displaced water.
- * Each of these is governed by “*invisible*” ***electrostatic*** “*action at a distance*” on (sub-) *microscopic* scales.

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What *Makes* Forces “*Invisible*”?

1. Too *small* to see. (Subatomic Scales)
2. Too *blurry* to see. (Quantum Mechanics)
3. Too *fast* to see. (“Want to see it *again*?”)
4. Too *weird* to see. (The Uncanny)

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Invisible Forces ***in other domains***

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- ***“Power to convince the mind”***

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Art, Music, Poetry, Literature...

Invisible Forces ***in other domains***

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Abuses of Social Media, Bad Laws...

Invisible Forces ***in other domains***

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Invisible Forces ***in other domains***

- ***“Power to convince the mind”***

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- ***“Body of armed men, a military organization”***

Proud Boys, Oathkeepers, others still unknown...