Science of Santa

Dr Steve Barrett

SSS 8 Dec 2022

Is Santa Compatible With the Laws of Physics?

How many laws of physics does Santa break?

Santa is (allegedly) a portly, jolly fellow with a white beard and a penchant for wearing red suits.

Although displaying questionable fashion sense, this does not mean that he cannot exist.

What about the claims made regarding his incredible feats?

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Is Santa Compatible With the Laws of Physics?

Santa (allegedly) visits all households on Christmas Eve to deliver presents to all qualifying * children.

(* Defined by his Naughty/Nice List)

Can we reconcile the incredible feats attributed to Santa with our understanding of science?

In particular, can we use any of the science described in my other talks?

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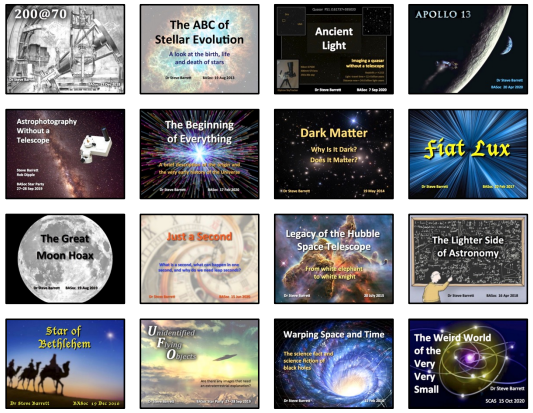
Other Talks



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Santa's (Alleged) Feats

Let's examine Santa's (alleged) feats …

Santa visits households
on Christmas Eve
to deliver presents to children

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How Many?

How many children get presents at Christmas?

Earth's population = 8 billion. 25% are children.
50% of these are eligible for Christmas presents.

So about a billion children
get Christmas presents *

* Assuming Naughty = 0%, Nice = 100%

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Transport

Can reindeer fly?

Insects fly … Birds fly … Pterosaurs fly (very rare these days) …
Even some mammals fly.

If reindeers can fly then they choose not to for a lot of the time.

There is very little evidence for
flying reindeer.

However, absence of evidence
is **not** evidence of absence.

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How Fast?

How fast could Santa and his sleigh fly?

To visit a billion children in one night (about 36 hours) Santa would have to travel at 2000 km/s or 0.007 c.

Moving at <1% of the speed of light, Santa is in no danger of defying the laws of physics.

No object can travel through space faster than light can travel in a vacuum. (Space can expand faster than that, but that's different.)

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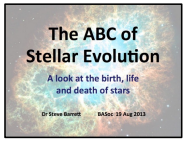
Roast Reindeer

Wouldn't the sleigh (and the reindeer) burn up?

Just as for a meteor or asteroid entering the Earth's atmosphere, the air in front of the sleigh would be compressed and heat up.



The '**C**' of the 'ABC' stands for '**C**ompression produces heat'

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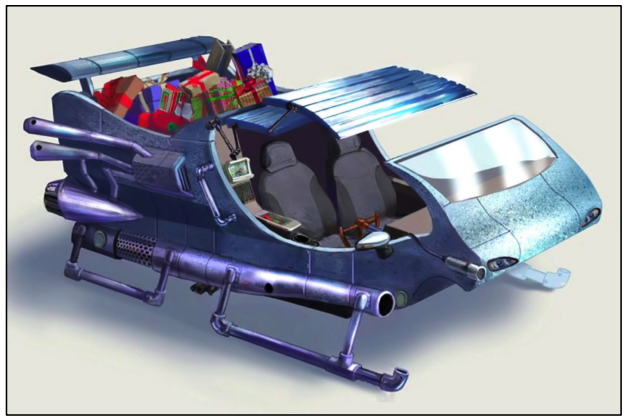
Aerodynamics



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Bright Light in the Sky

Wouldn't the heat make the sleigh glow white-hot?

Compression produces heat, and hot objects radiate light, so Santa and the sleigh ought to be easily visible.

Maybe it was …

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Bright Light in the Sky

Wouldn't the heat make the sleigh glow white-hot?

Compression produces heat, and hot objects radiate light,
so Santa and the sleigh ought to be easily visible.

Or …

Maybe it *is* …

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Stealth Sleigh

Wouldn't the heat make the sleigh glow white-hot?

What do we know about that does not emit or reflect light,
or indeed any other type of electromagnetic waves?

Santa and his sleigh are
made of Dark Matter!

(This also explains why the sleigh does not show up on radar.)

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Santa's (Alleged) Feats

Let's examine Santa's (alleged) feats …

Santa visits households
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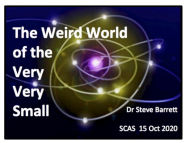
Chimneys

How could Santa get down so many chimneys?

To visit a billion children in one night Santa would
have to squeeze down 3000 chimneys each second.



Atom = nucleus + electrons

Replacing the electrons with
heavier muons would make
the atoms smaller.

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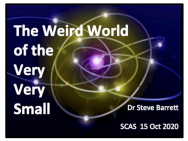
Chimneys

How could Santa get down so many chimneys?

But that doesn't help much if a house or apartment doesn't have a chimney. How could Santa get inside?



Quantum mechanics to the rescue again! An object can 'tunnel' through a door or wall and appear on the other side.

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Santa's (Alleged) Feats

Let's examine Santa's (alleged) feats ...

Santa visits households
on Christmas Eve
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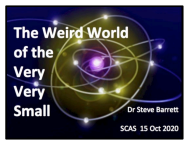
All In One Night

How can Santa make so many deliveries in one night?

Even if travelling at relativistic speeds between each delivery, how can everything be done in one night (about 36 hours)?



Sub-atomic particles can be in two places at one time, so why can't Santa?

If for some reason Santa could only be in one place at a time, then he would need an alternative way to make the deliveries.

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All In One Night

How can Santa make so many deliveries in one night?

Even if travelling at relativistic speeds between each delivery, how can everything be done in one night (about 36 hours)?

Santa would have to be capable of manipulating space and time.

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Santa's Sack

How could Santa carry all the presents?

One present for each of one billion children?
How could the sleigh hold that many presents?

One solution is to warp space in such a way that the sleigh is bigger on the inside than the outside (just like a black hole).

Alternatively, just store all the presents in another dimension. We know of 3 dimensions of space, but there may be more. A lot more.

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Energy

Wouldn't all that need a HUGE amount of energy?

Santa + sleigh + a billion presents moving at relativistic speeds would need an incredible amount of energy.

A black hole could power a starship, so why not a sleigh?

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Energy

Wouldn't all that need a HUGE amount of energy?

Alternatively, there's an energy source that we are overlooking …
the elephant in the room …

What if Santa could convert the mass of all the mince pies into energy: $E = mc^2$

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Energy

Wouldn't all that need a HUGE amount of energy?

One mince pie: $E = mc^2 = 50g \times c^2 = 5 \times 10^{15}$ J

If a few % of households leave a mince pie for Santa

20 million mince pies $\Rightarrow$ $20 \times 10^6 \times 5 \times 10^{15}$ J

$= 10^{23}$ J

(that's about the same as the energy output of a nuclear power station running for a million years)

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Energy

Wouldn't all that need a HUGE amount of energy?

How do you extract $E = mc^2$ from a mince pie?

Mince Pie

Anti- Mince Pie

... in the Large Mince Pie Collider at CERN.

But where do you get the anti- mince pies from?

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Energy

Wouldn't all that need a HUGE amount of energy?

An alternative way to extract (most of) $E = mc^2$ from a mince pie ...

Drop the mince pies into a black hole.

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Energy

Wouldn't all that need a HUGE amount of energy?

An alternative way to extract (most of) $E = mc^2$ from a mince pie ...

Matter falling into a black hole can produce a quasar, where the matter (probably not mince pies) is converted into radiation.

How much energy could be released using mince pies? I can't find any research papers on this topic as very few studies have been carried out.

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How?

How could Santa actually do all that?

Although all of these possibilities are allowed by the laws of physics, how could Santa manipulate space and time?

Who says Santa has to be human?

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Is Santa Compatible With the Laws of Physics?

How many laws of physics does Santa break?

NONE

So feel free to draw your own conclusions about the existence or otherwise of the portly, jolly fellow with a white beard and a penchant for wearing red suits.

Regardless of your conclusion…

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Merry Christmas

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www.liverpool.ac.uk/~sdb/Talks

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