



MAGLEV TRAINS

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Overview

The Physics

- Magnetic field lines
- How are magnetic fields produced
- Earth's magnetic poles
- Superconductors

Demo

Real world examples

- Application of theory
- Incheon Airport (Korea)
- SCMaglev (Japan)
- Hyperloop
- Pros / Cons

Theory

Magnetic Field Lines

- Magnets have two poles: North & South
- "Field lines" coming out of the two poles
- Out of North pole
- Into South pole
- Dipoles

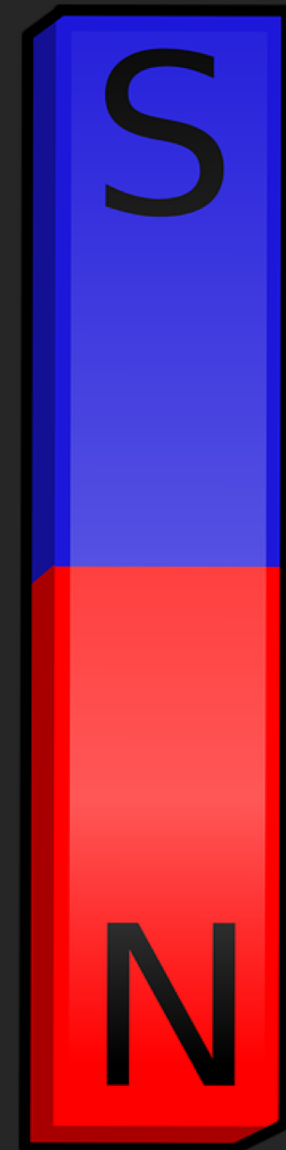
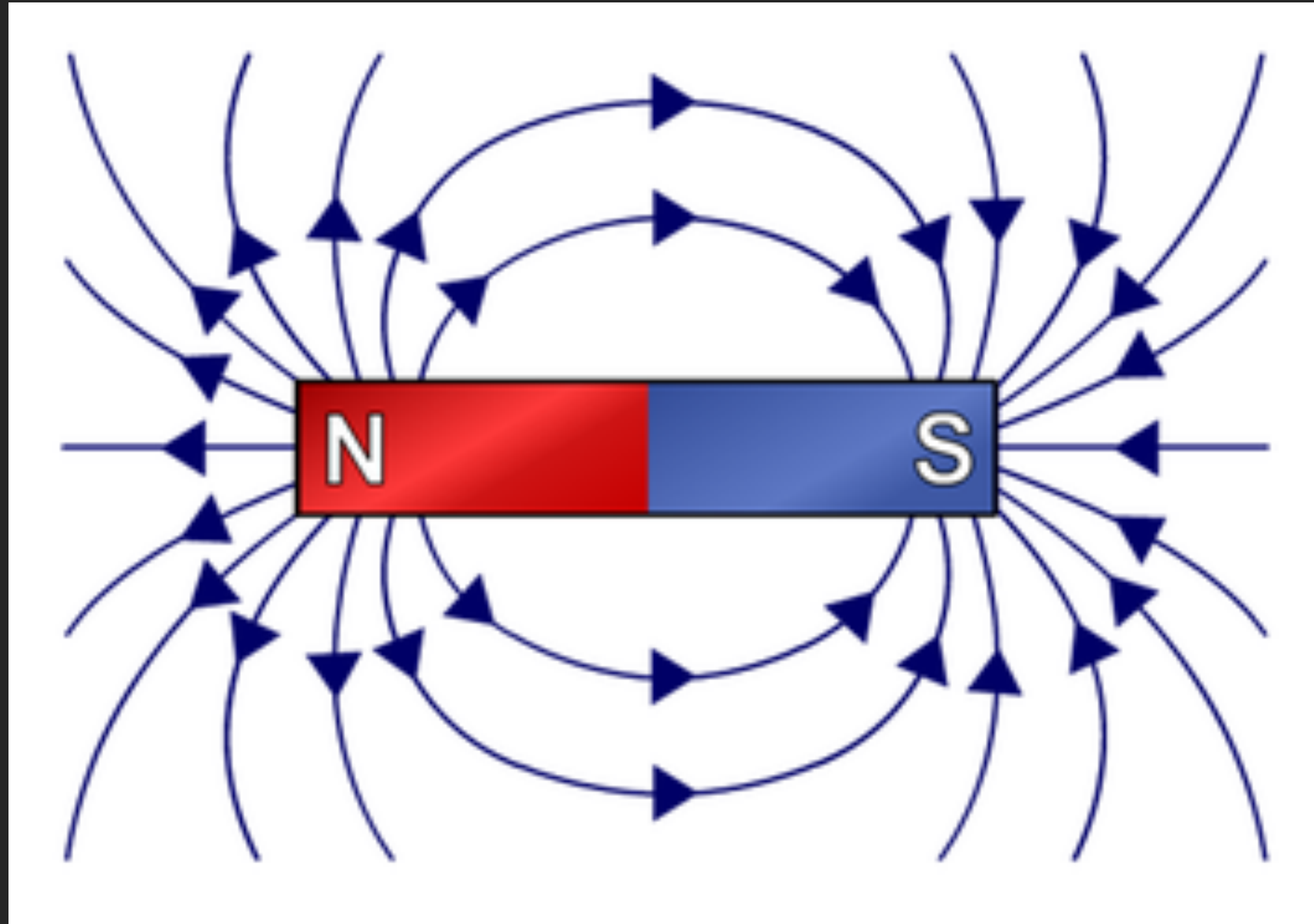


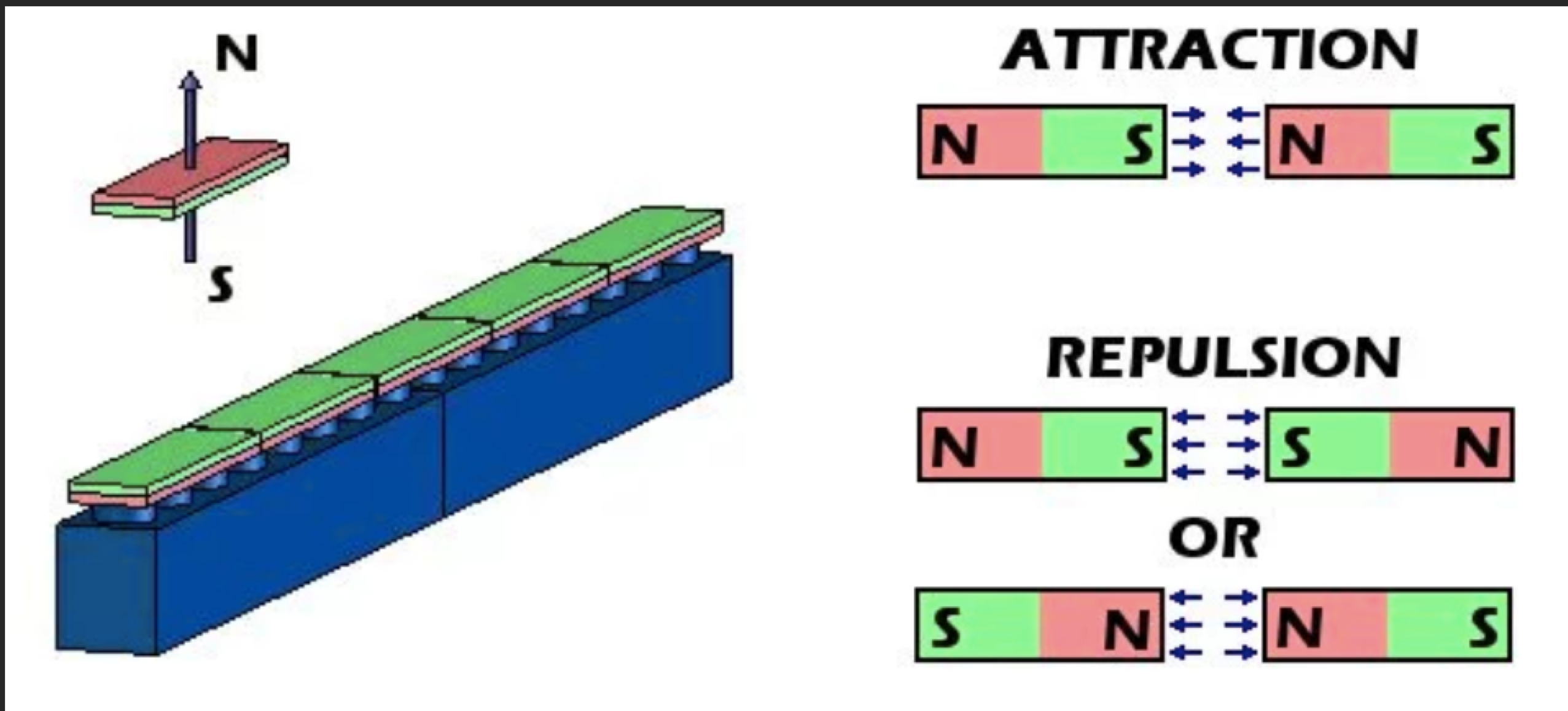
Image retrieved from: <https://pixabay.com/en/bar-magnet-magnetic-physics-poles-35424/>

Magnetic Field Lines

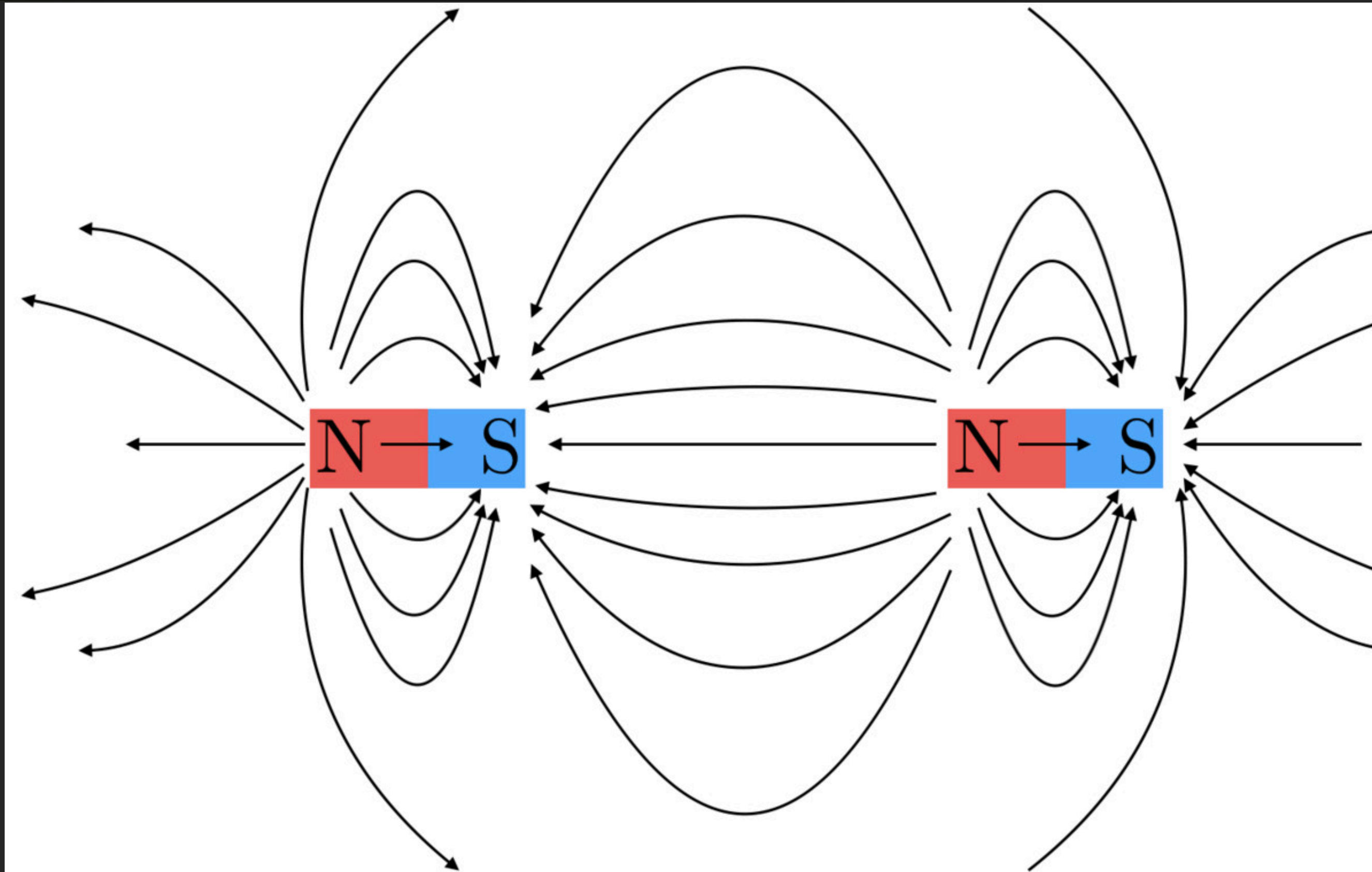


How do two magnets interact?

Magnetic Field Lines



Magnetic Field Lines

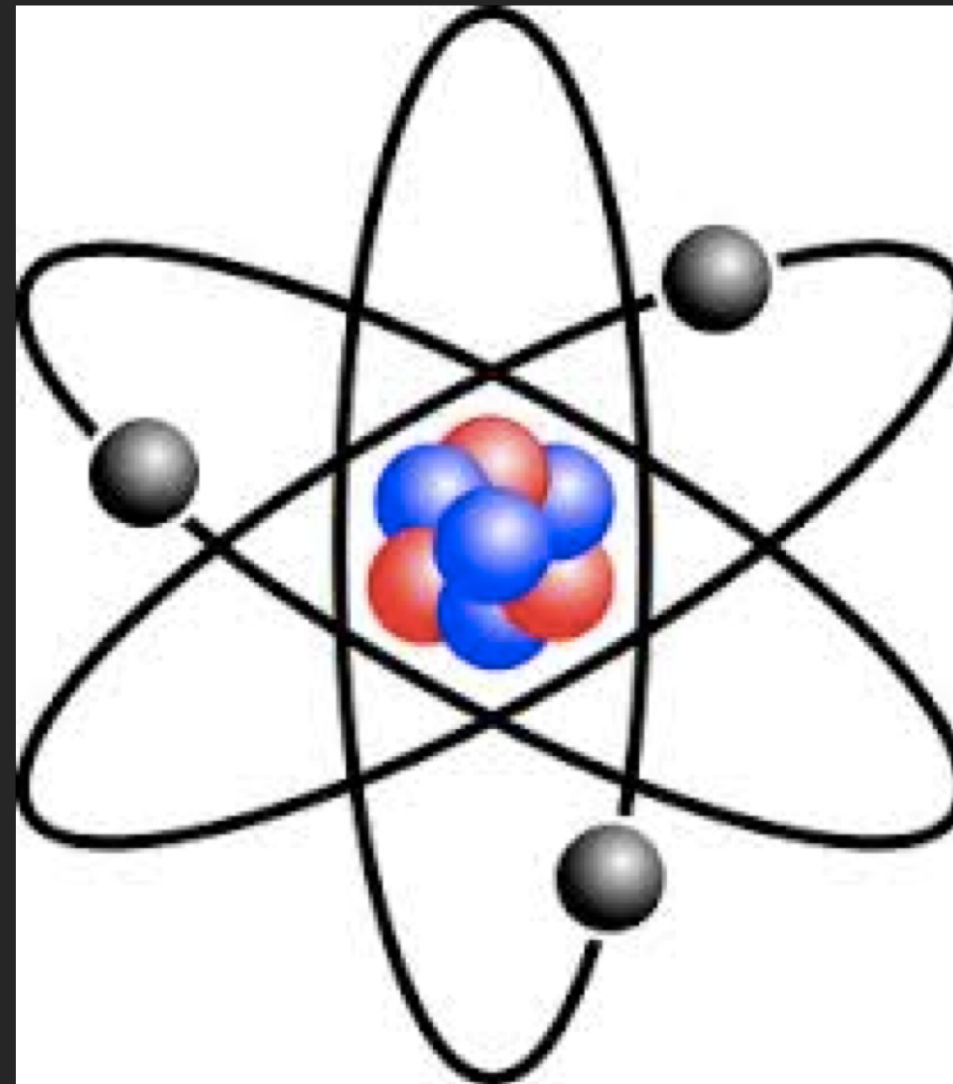


How are magnetic fields produced?

- Moving a charge, like an electron
- Similarly, when current (a flow of electrons) passes through a conductor (wire)

Okay but what gives a permanent magnet its magnetism?

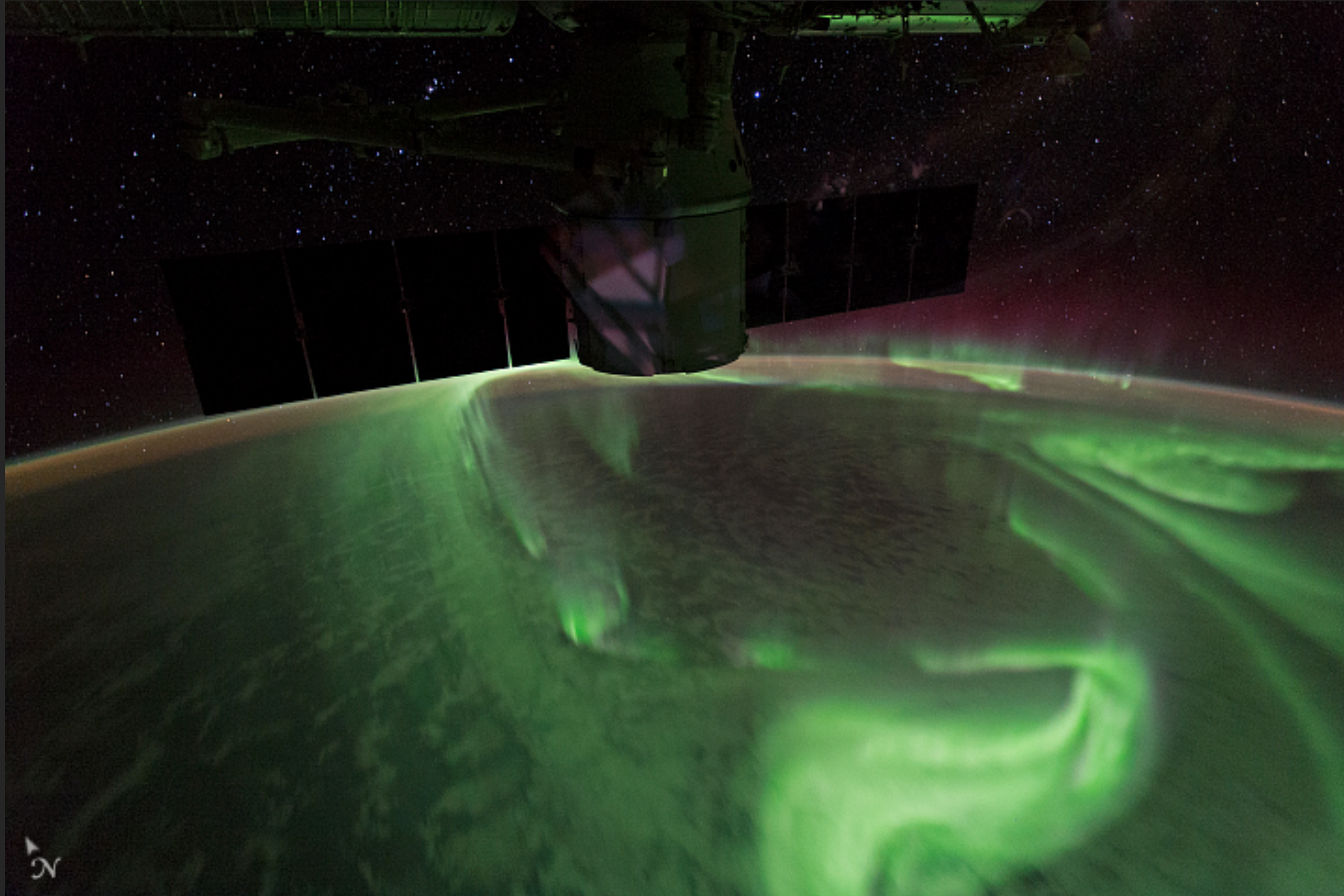
- Motion of the electrons in the atoms



Why does the earth have magnetic poles?

- Electric currents due to the movement of molten iron in the Earth's outer core
- The resulting magnetic fields extends into space!
- Protects us from harmful solar wind

Aurora Borealis / Australis



Superconductors

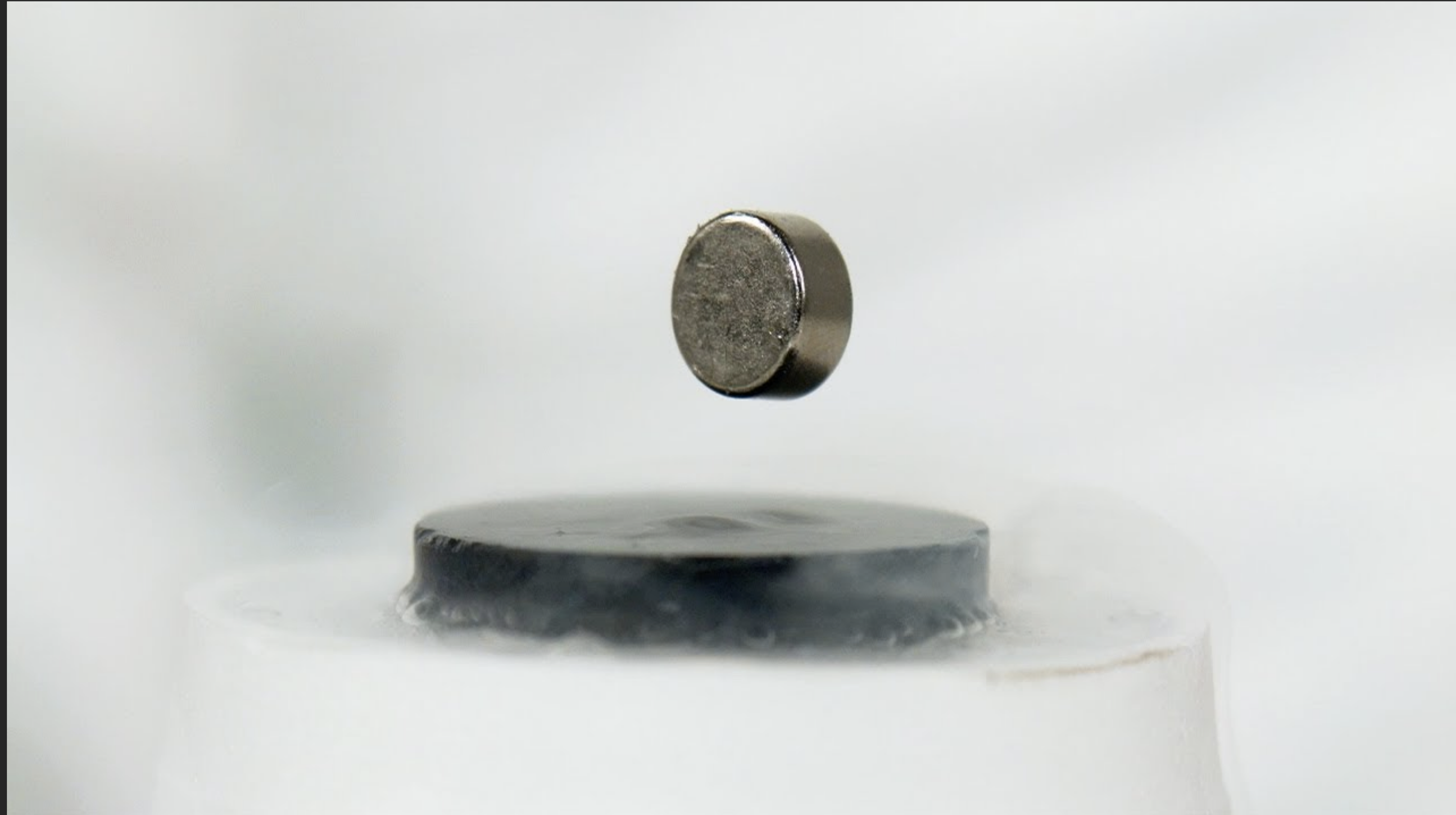
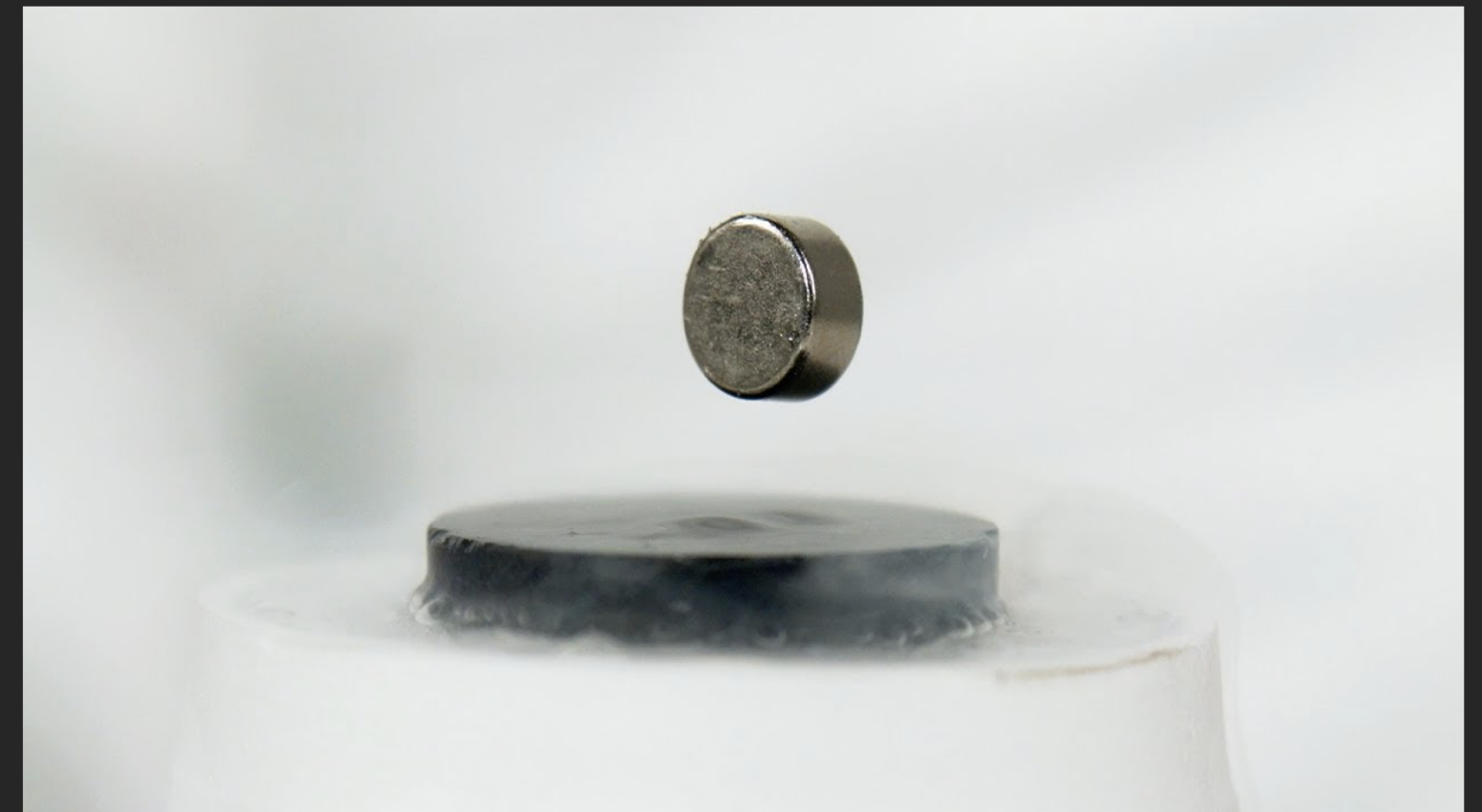


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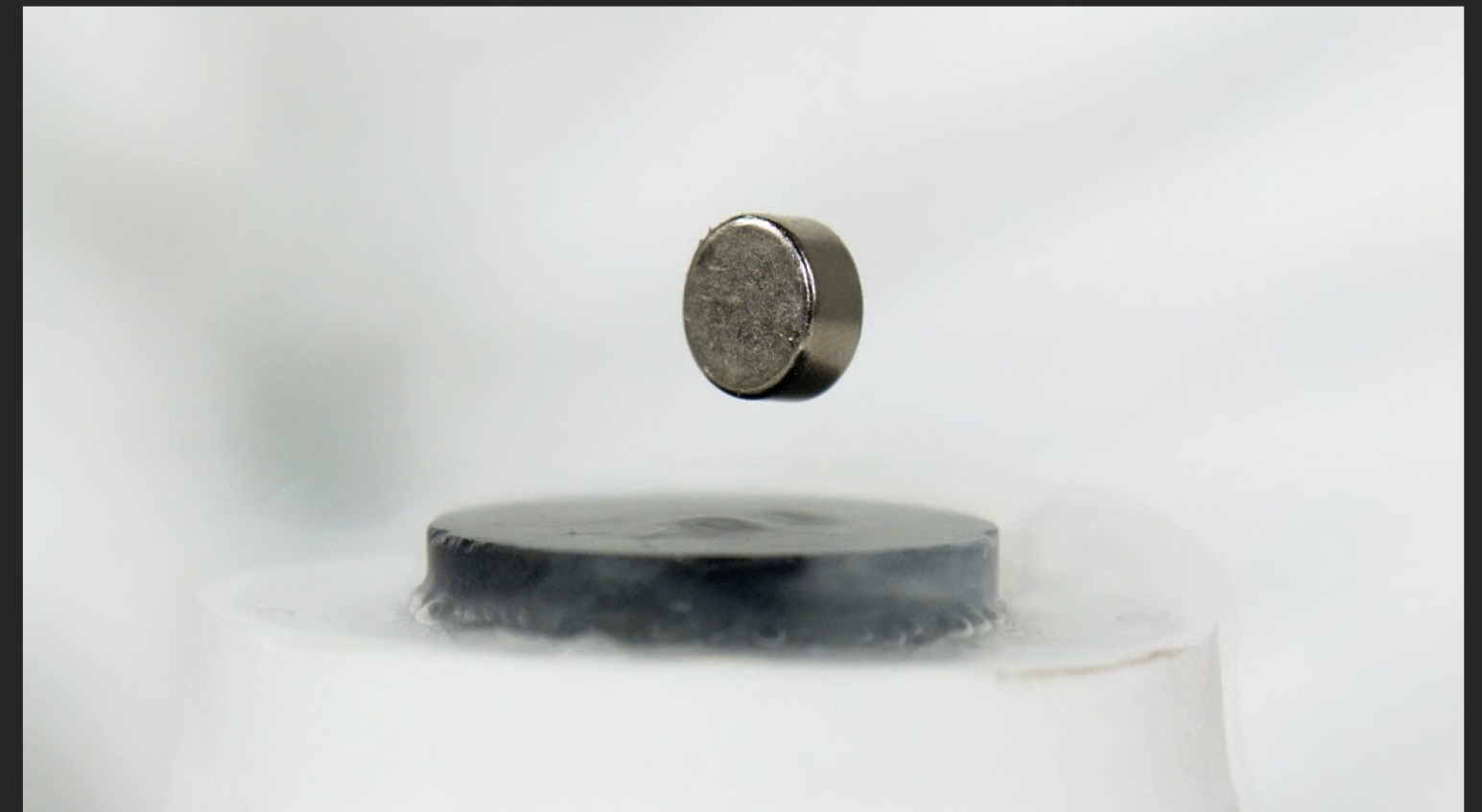
Superconductors

- Zero resistance conductors at low temperatures
- Electrons can move atom to atom without resistance
- Circuits can be left in cold fluid for years – zero resistance!

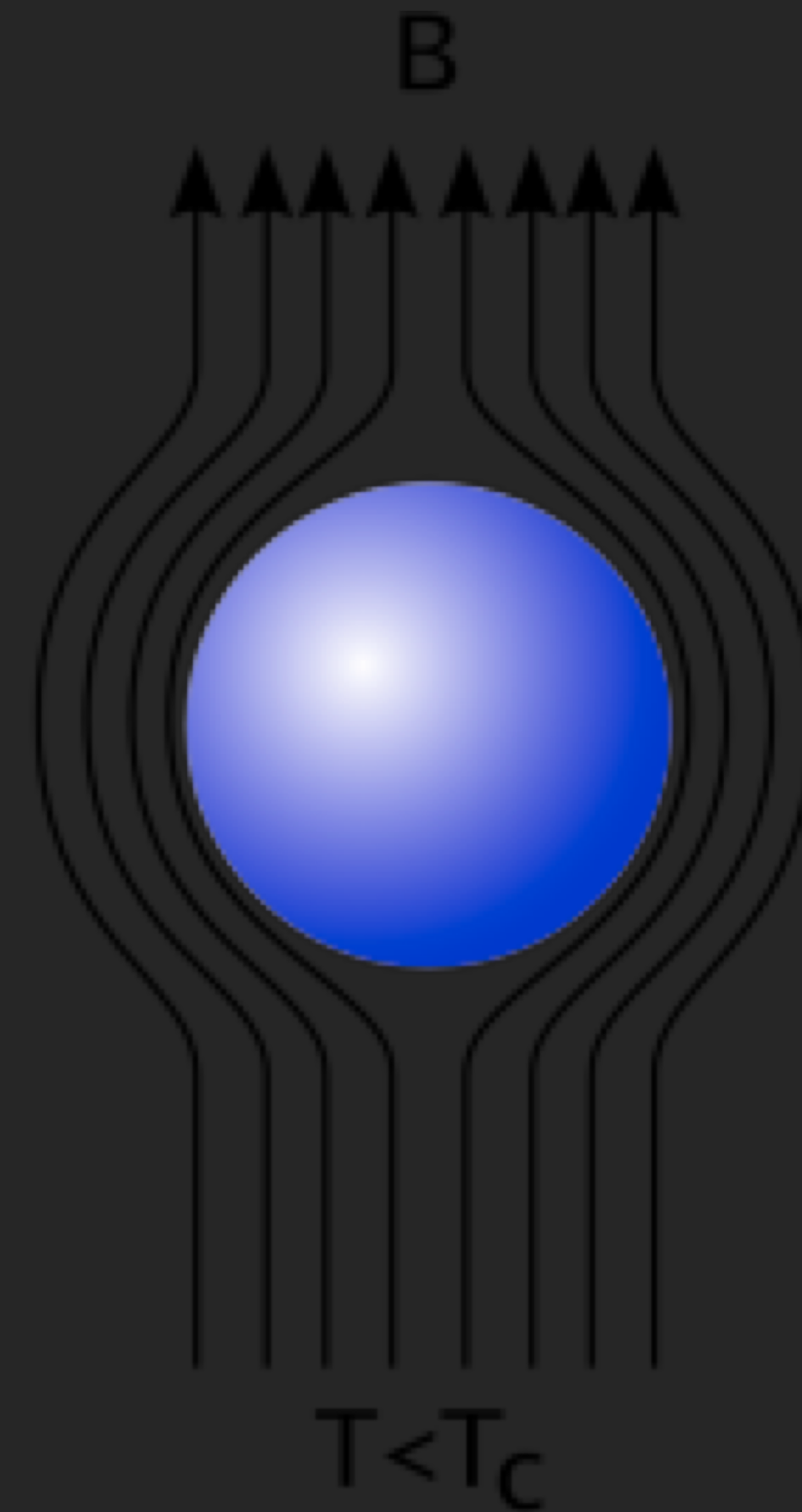
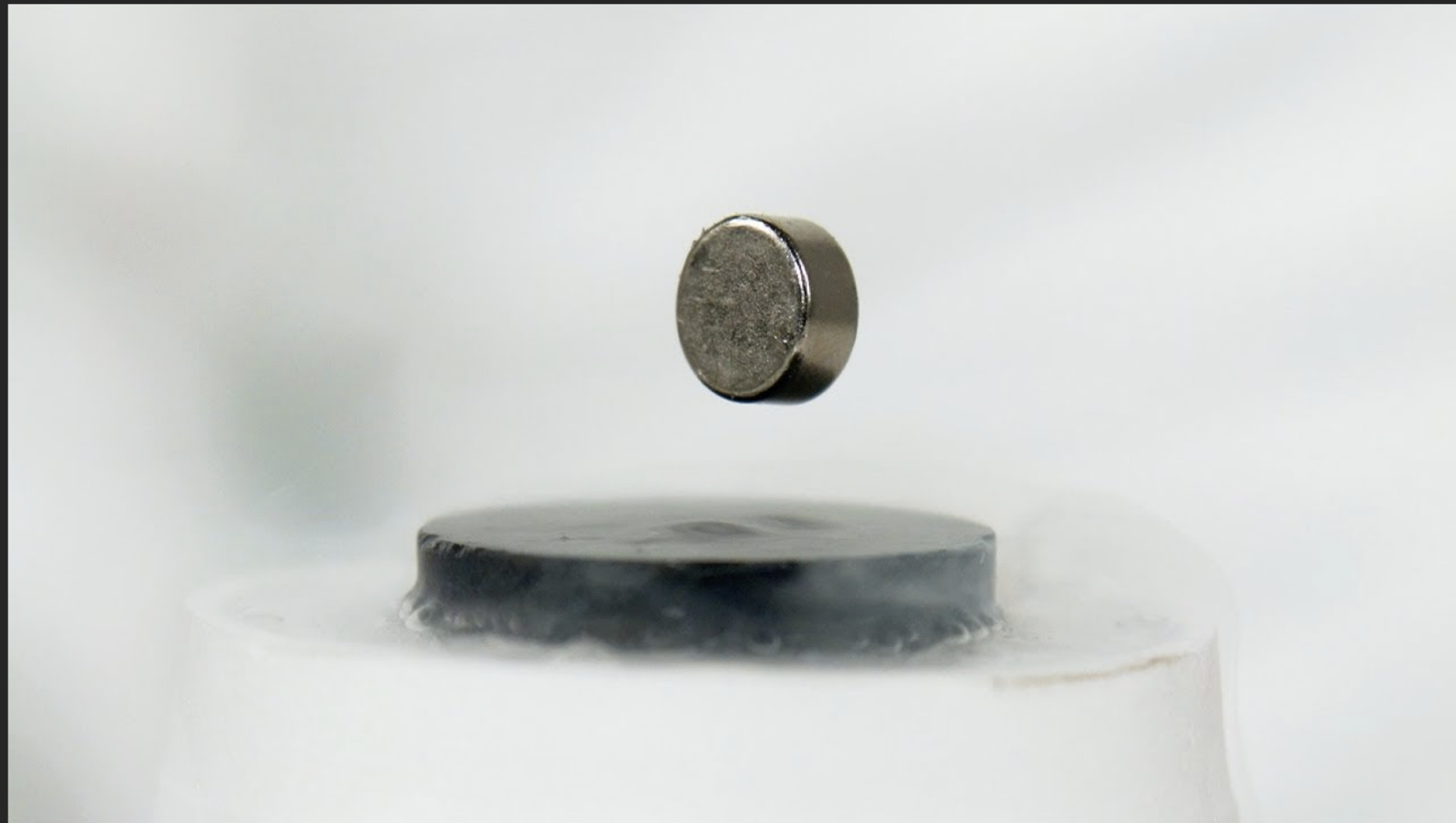


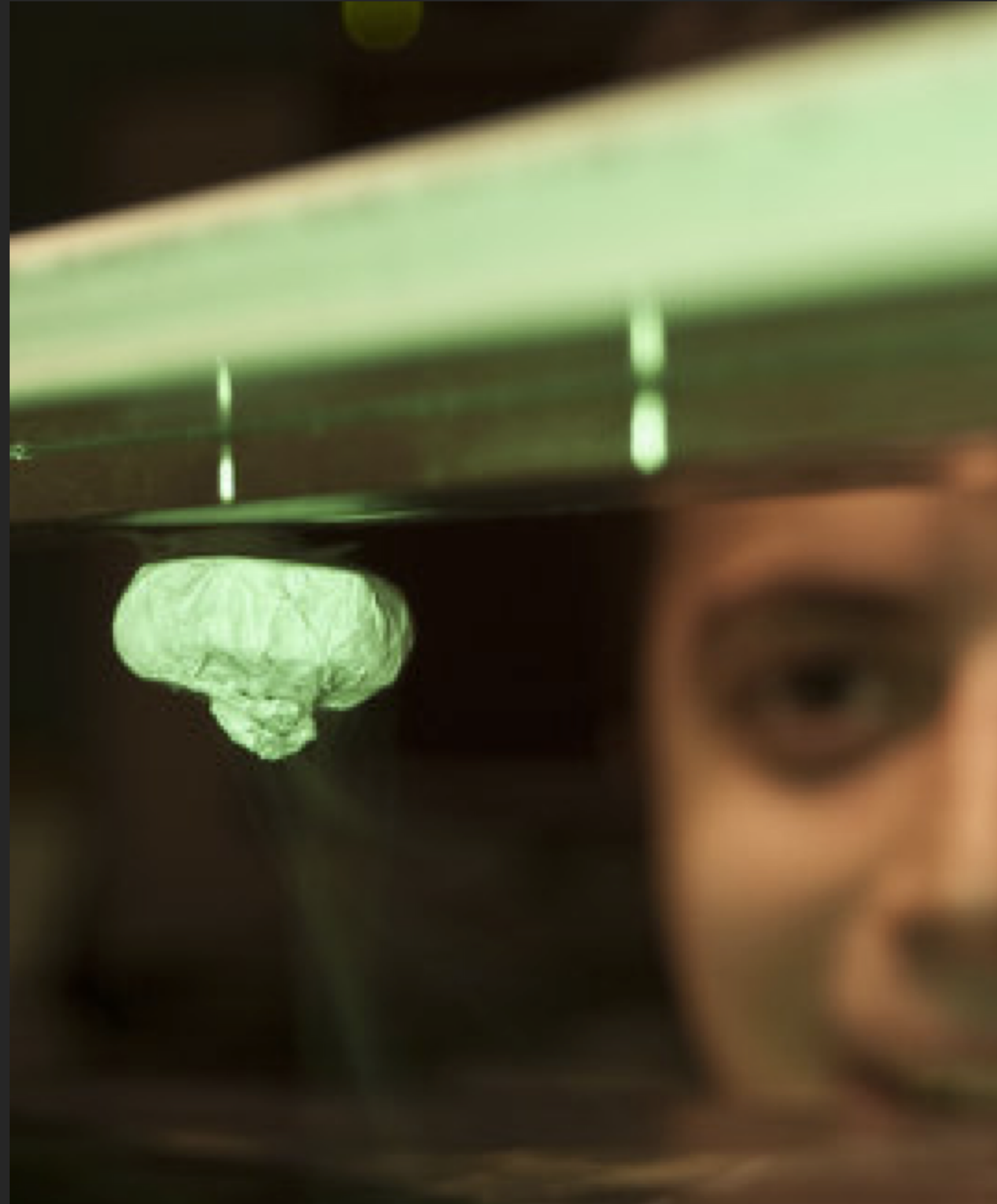
Meissner Effect

- Expulsion of magnetic fields after transition to superconducting state
- Always a repulsive effect, regardless of N or S fields



Meissner Effect





Maglev Trains

What are Maglevs?

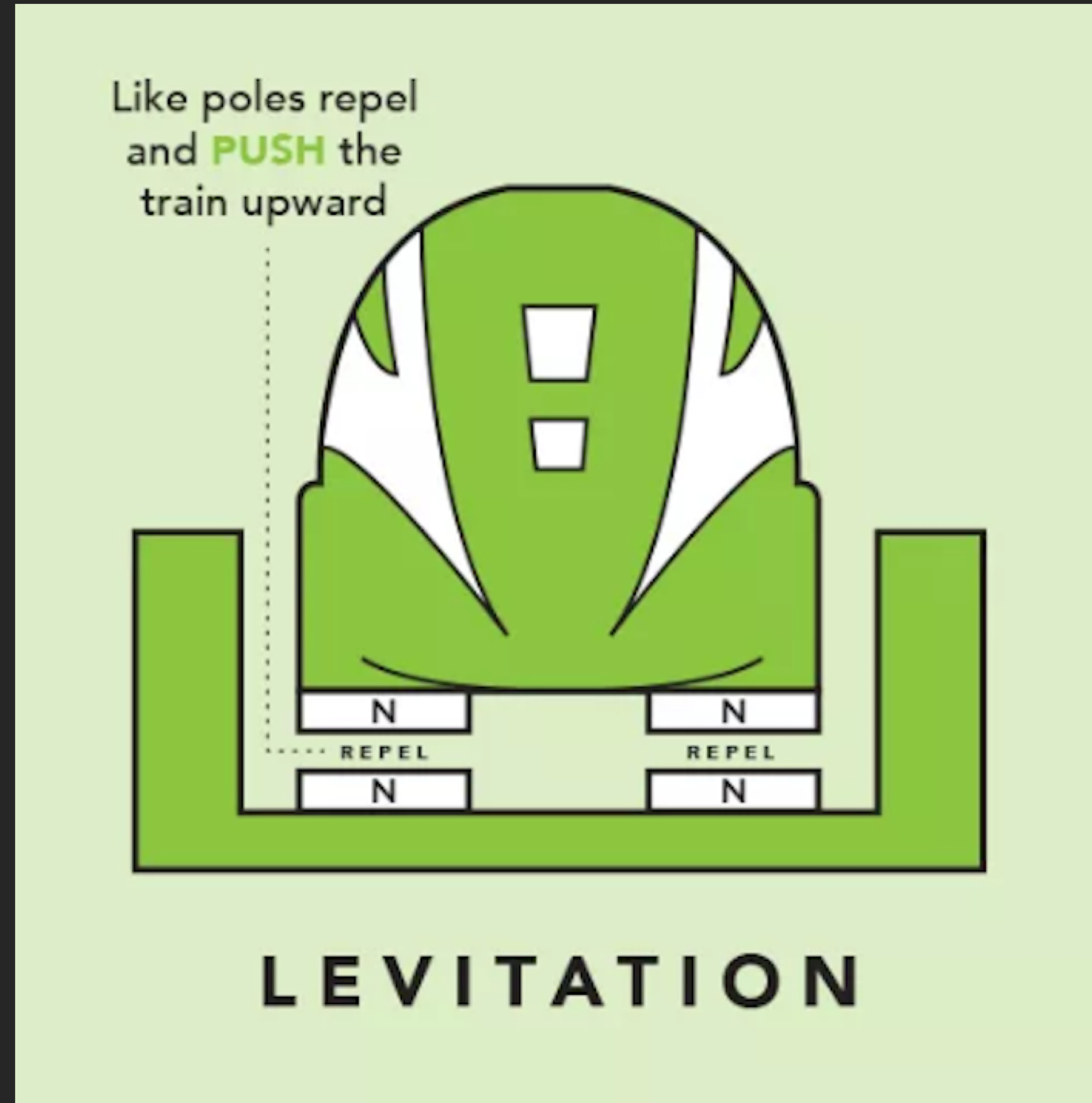
- Trains that take advantage of the fact that like magnets repel
- Great speed advantage over regular trains
- Medium range routes (200-400 miles)
- Currently operating in Japan, Korea, China

How do Maglevs work?

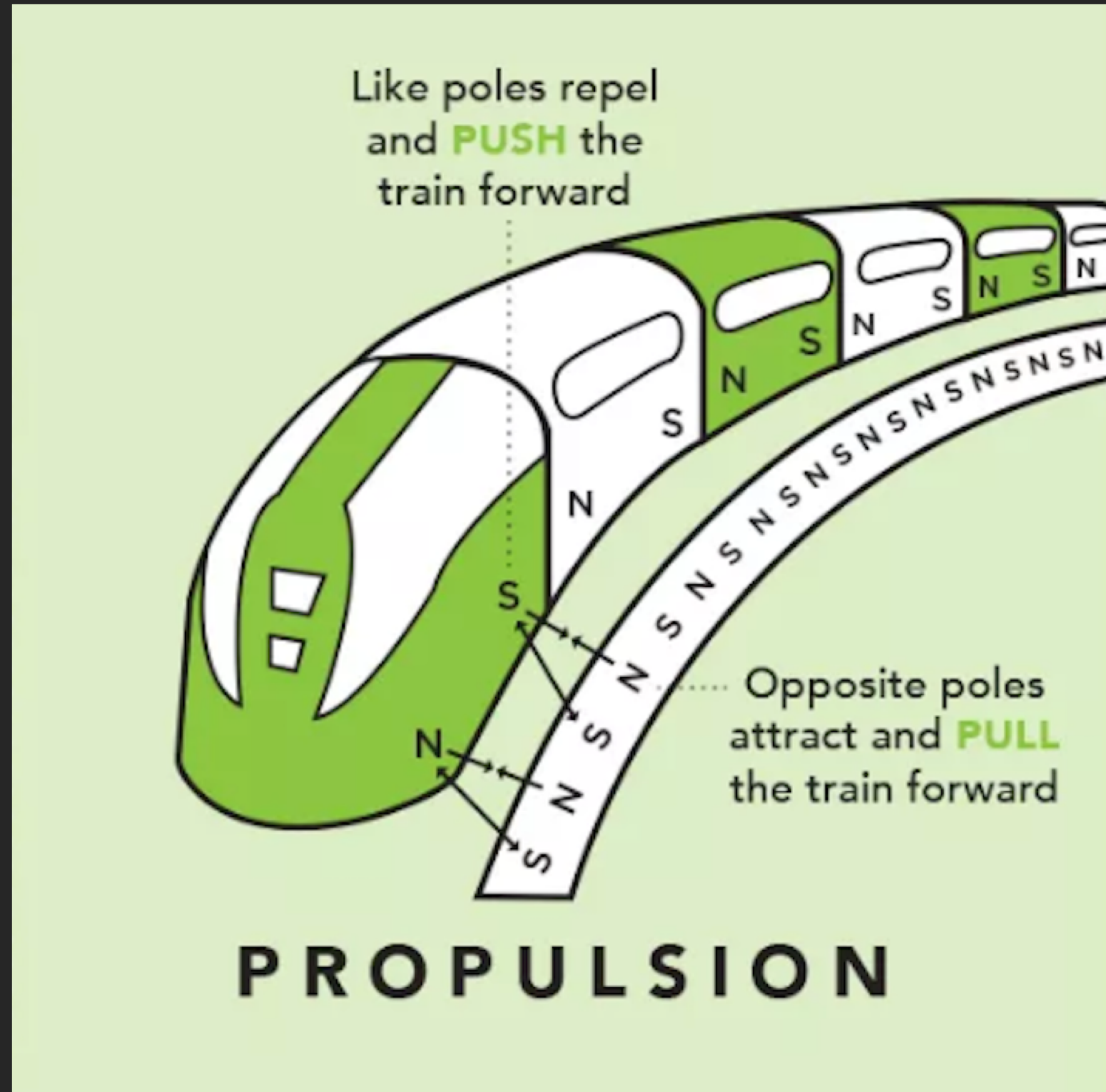
3 mechanisms

- Vertical – allows train to hover (~5 inches)
- Horizontal – keeps train stable
- Propulsion system using electricity (attractive and repulsive forces)

Vertical Suspension



Horizontal Propulsion



Incheon Airport Maglev – Korea

- Operational
- 100 km/h
- 2 cars
- 115 persons / car
- 19-26.5 tonnes / car

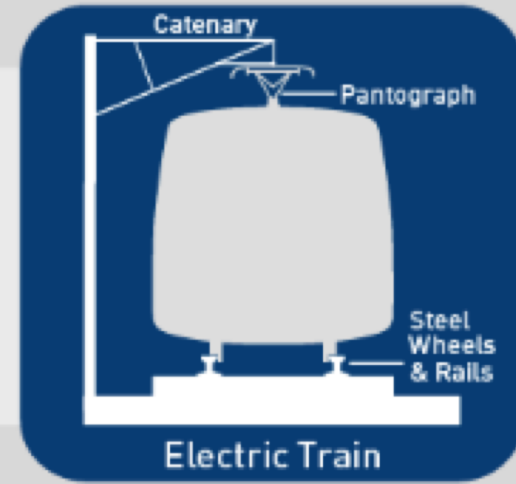
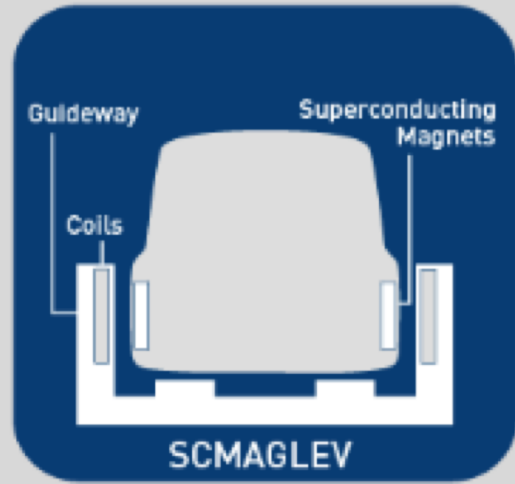


SCMaglev – Japan

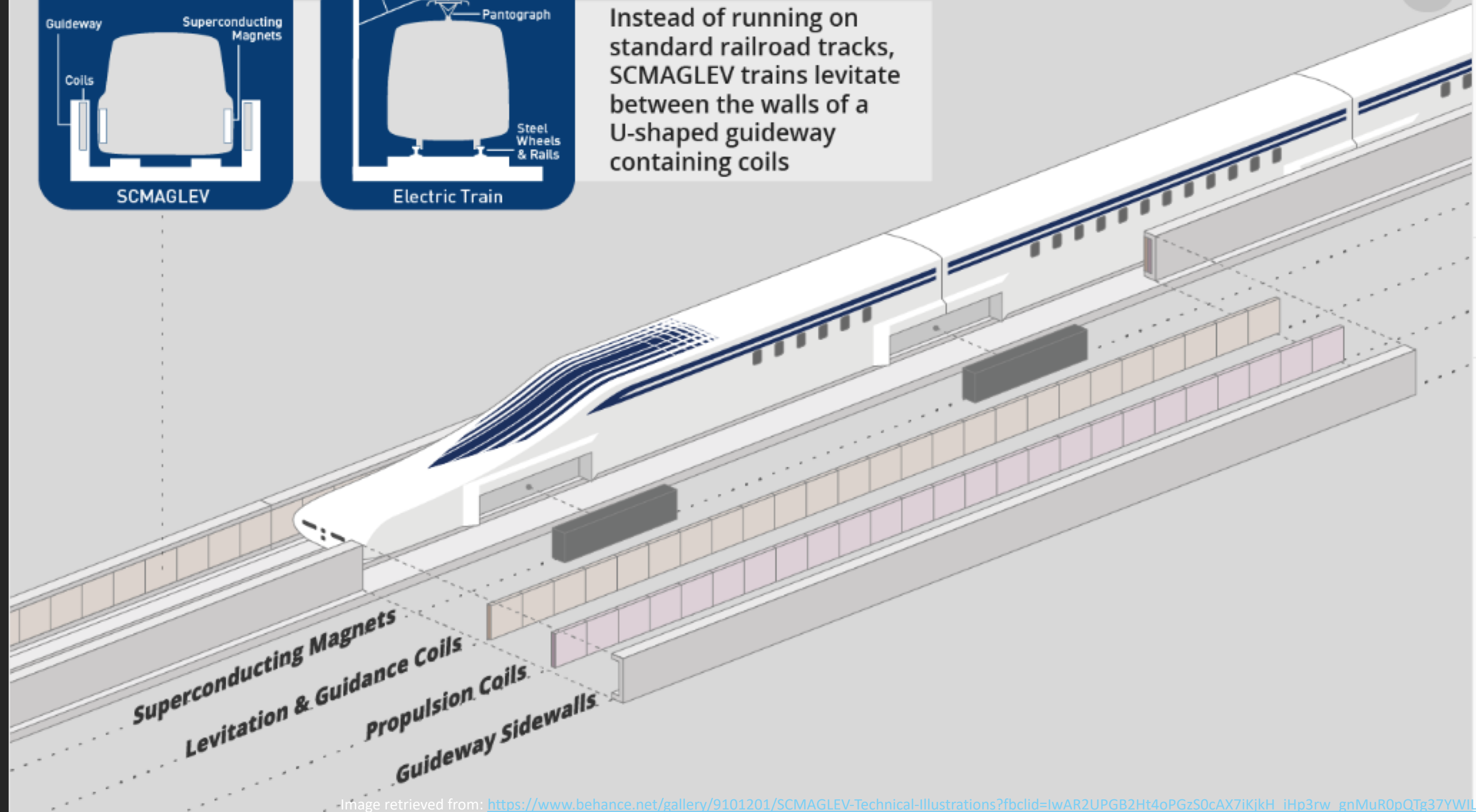
- 603 km/h
- 7 cars
- 43km track
- 24-68 persons / car



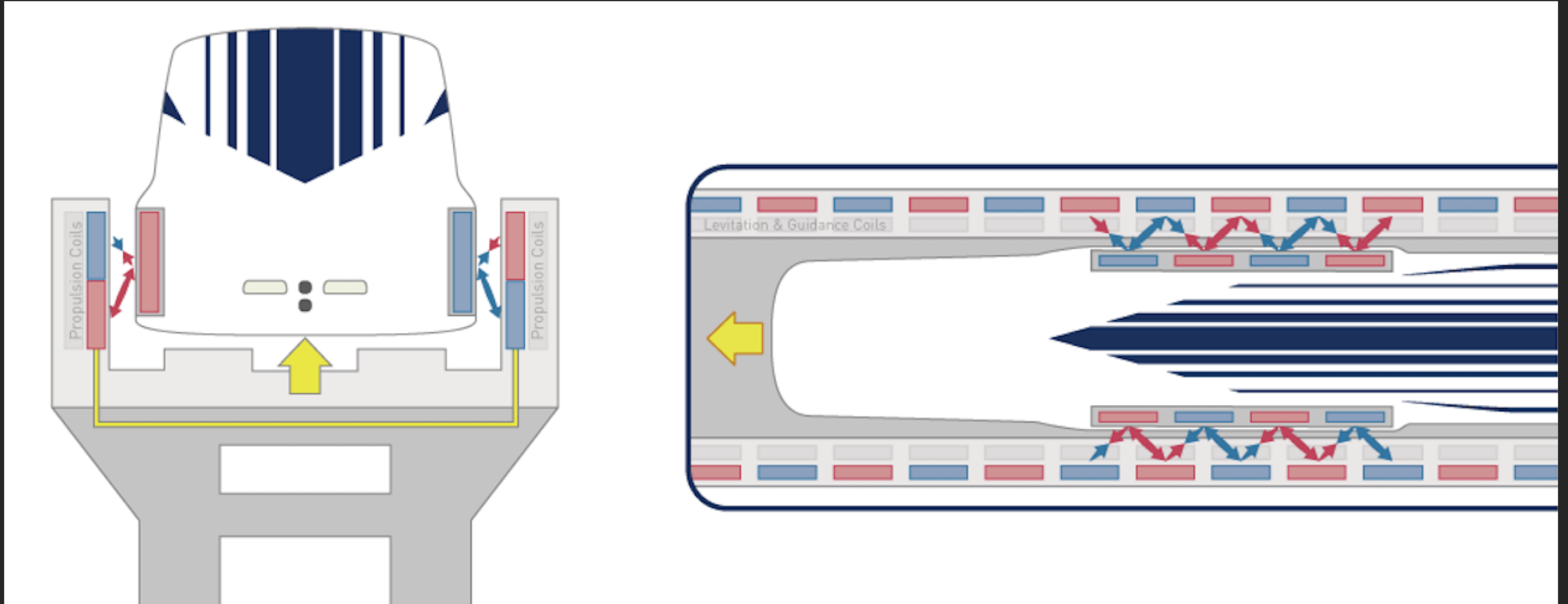
SCMaglev – Japan



Instead of running on standard railroad tracks, SCMAGLEV trains levitate between the walls of a U-shaped guideway containing coils



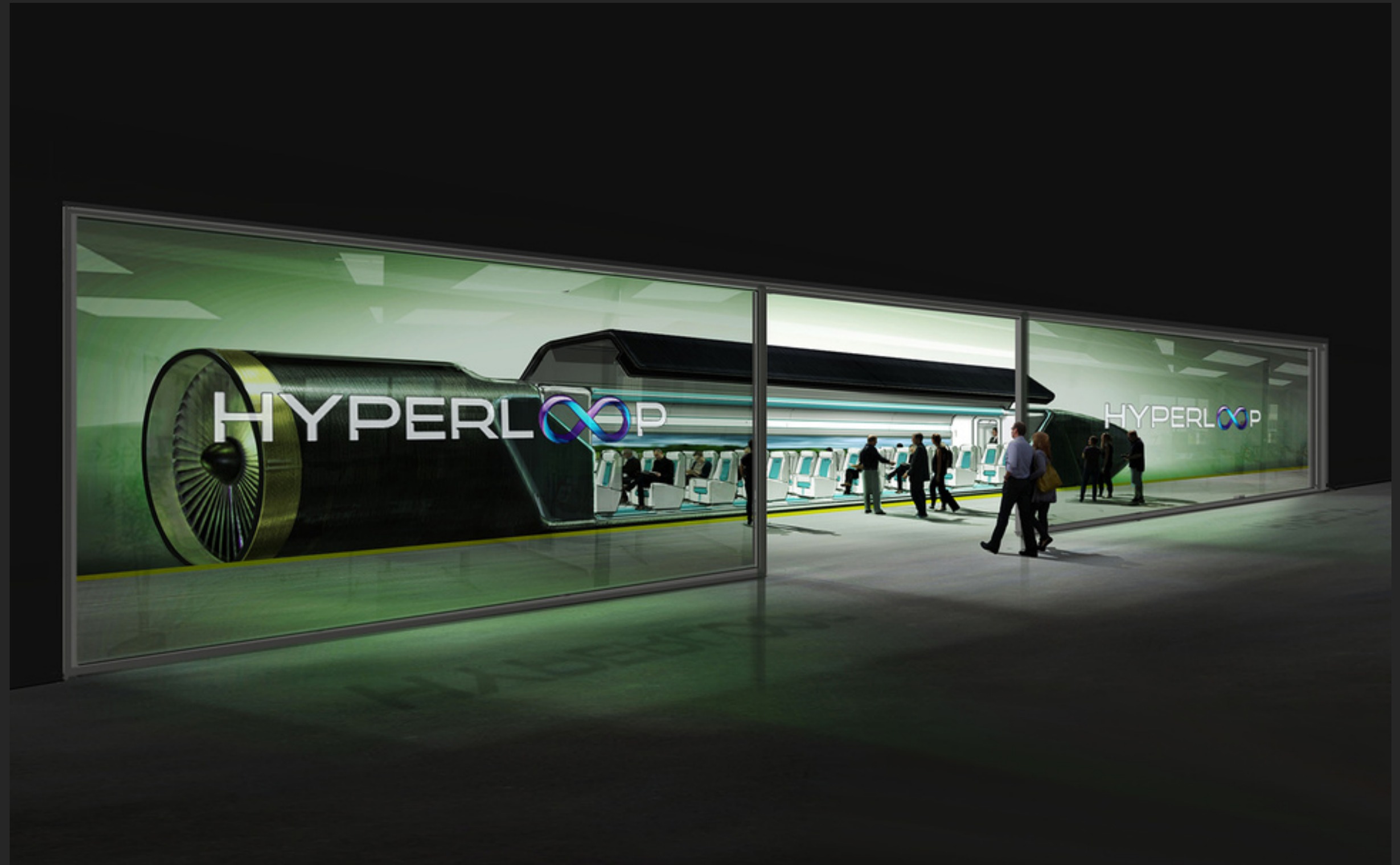
SCMaglev – Japan



In action

Hyperloop – Tesla / SpaceX

- 1200 km/h
- LA to San Fran (560km)
- Same thing, but let's now pump out the air!
- "cross between a Concorde and a railgun and an air hockey table"
- Mars



Benefits of Maglevs

- Reduces / removes problem of friction → much higher speeds!
- Cheaper to operate, less depreciation
- Little to no air pollution
- Less turbulence and noise than traditional trains
- Traditional derailment eliminated

Cons of Maglevs

- Huge start-up infrastructure costs
- Require rare earth metals

If Maglevs are so cool, why don't we have them already?

Costs!





THANK YOU!

Any Questions?



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Image retrieved from: <https://www.kisspng.com/free/thomas-friends.html>