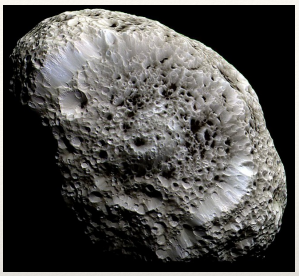


Hieronymus Bosch: *Temptation of St Anthony*

Art and the Cosmos: Space Travel

Sandra Paikowsky (Concordia University)
Peter Watson (Carleton University)

Albrecht Altdorfer
detail, *Crucifixion*, c.1520
tempera on wood, 30"x 22"
Museum of Fine Arts
Budapest

Jacob's Ladder
Book of Hours for
Duchess Mary of Guelders
1400s
Berlin State Library

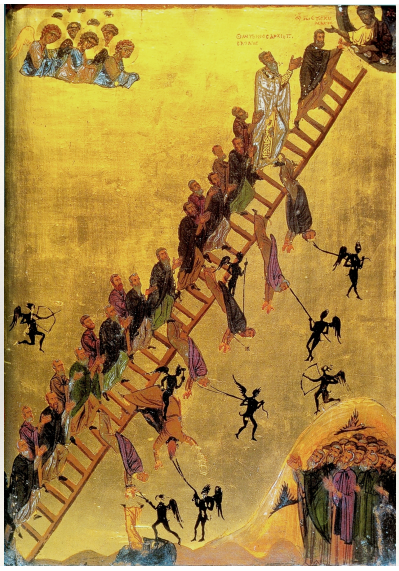
Jacob set out for Harran. When he reached a certain place, he stopped for the night because the sun had set. Taking one of the stones there, he put it under his head and lay down to sleep. He had a dream in which he saw a stairway resting on the earth, with its top reaching to heaven, and the angels of God were ascending and descending on it. There above it stood the Lord, and he said: "I am the Lord, the God of your father Abraham and the God of Isaac. I will give you and your descendants the land on which you are lying. Your descendants will be like the dust of the earth, and you will spread out to the west and to the east, to the north and to the south.

Jacob's Ladder
illuminated manuscript
1300s ?

Giorgio Vasari, *Jacob's Ladder*, 1557, oil on panel, 88x93", Walters Art Gallery, Baltimore

William Blake,
Jacob's Ladder, c. 1805,
pencil , ink and watercolour
14" x 12",
British Library

Ladder of Divine Ascent
12th. century
tempera and gold leaf on wood
16"x 12"
Saint Catherine's Monastery, Mount Sinai.



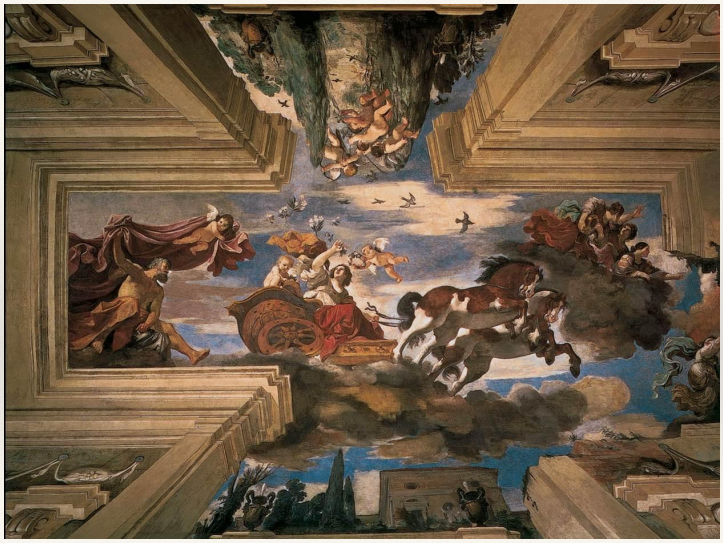
St. John Goes to Heaven, 14th. c.
British manuscript illumination

Ezekiel in his Chariot
French manuscript illumination, 14th. C.

Elijah in his Chariot c. 1300
French manuscript illumination

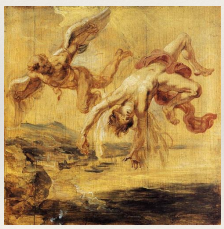
Giuseppe Angeli, *Elijah Taken to Heaven*, c. 1750, oil on canvas, 69"x 104", National Gallery of Art, Washington

Guercino, *Aurora in her Chariot*, 1621, fresco, Casino di Villa Boncompagni Ludovisi, Rome



Guercino, *Aurora*, entire ceiling

Rubens and Jacob Peter Gowi
Fall of Icarus, 1636-37
oil on canvas, 185"x 150"
Prado Museum



Ruben's *Fall of Icarus*, 1636

Giotto, *Ascension of Christ*, 1305, fresco, Scrovegni Chapel, Padova

Ascension of Christ
Book of Hours of Alice de Reydon, 14th. c.
Cambridge University

Rembrandt
Ascension of Christ, 1636
oil on canvas, 38"x 28"
Alte Pinakothek,, Munich

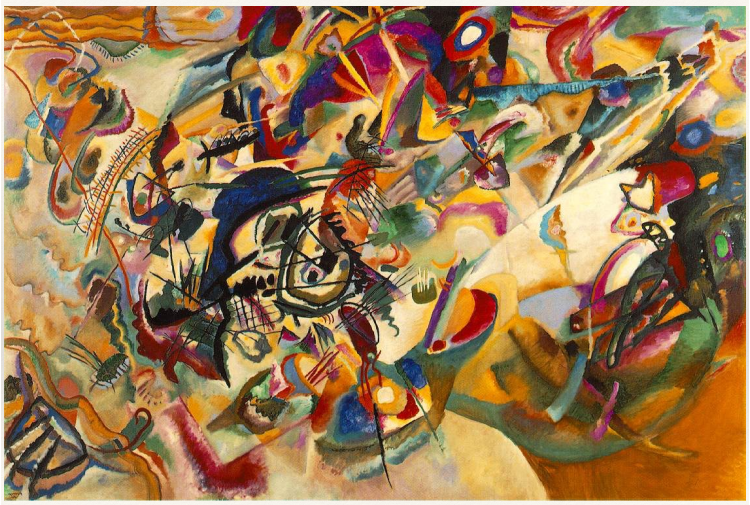
Silvestro de' Gherarducci
Assumption of the Virgin, 1365
tempera on wood 16"x 11"
Vatican Museum

Titian
Assumption of the Virgin, 1516
oil on canvas, 23' x 12'
Church of the Frari, Venice

Murillo
Assumption of the Virgin
1670
oil on canvas, 74"x 58"
Hermitage

Assumption of Mary Magdalen, 1430
tempera on panel, 71"x 48"
National Museum, Warsaw

Giotto, *Ascension of St. John the Evangelist*, 1315, fresco, Peruzzi Chapel, Santa Croce, Florence

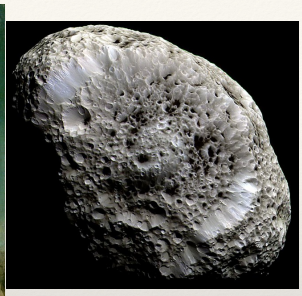


Kandinsky, *Composition VII*, 1913, oil on canvas, 79" × 119", State Tretyakov Gallery, Moscow

Mark Rothko
Black in Deep Red, 1957
oil on canvas, 70″x 54″
private collection

Paul-Émile Borduas
Black Star, 1957
oil on canvas 64″x52″
Montreal Museum of Fine Arts

Hieronymus Bosch: *Temptation of St Anthony*

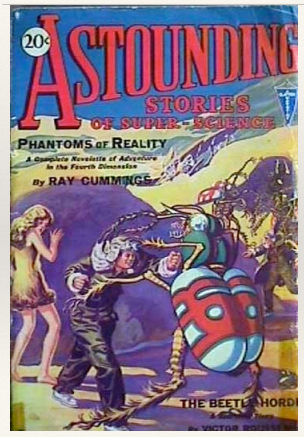


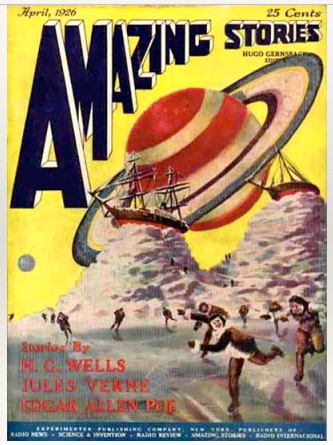
Hyperion

Art and the Cosmos: Space Travel

Sandra Paikowsky (Concordia University)
Peter Watson (Carleton University)

We have always needed artists to tell us what is out there





Lucian of Samosta:

True History" (200 AD):

trip to Moon and Sun via waterspout and encounters with aliens

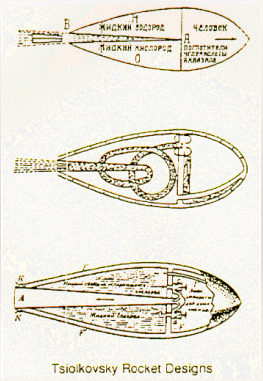
- That spot, he told us, which now looked like a moon to us, was the earth.

Earth-rise from Apollo 8

Cyrano de Bergerac:

- 1619-1655: French writer, (with a big nose!) around whose name a number of unhistorical legends accumulated..
- "États et Empires de la Lune" (1657)
- "Histoire comique des états du Soleil" (1662)
- (yes, published posthumously).
- Ship was propelled by firecrackers…

Escaping Earth



- 1920's Tsiolkovsky, Goddard
- First Liquid Fuelled Rocket

A Severe Strain on Credulity

(New York Times, 13 January, 1920)

As a method of sending a missile to the..highest part of the earth's atmospheric envelope, Professor Goddard's multiple-charge rocket is a practicable, and therefore promising device.

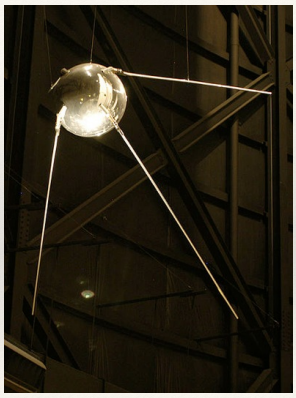
That Professor Goddard, with his "chair" in Clark College … does not know the relation of action to reaction, and of the need to have something better than a vacuum against which to react--to say that would be absurd. Of course he only seems to lack the knowledge ladled out daily in high schools

"space travel is utter bilge"

Richard Woolley

Astronomer Royal 1956

- First artificial satellite: Sputnik 1 ("Спутник-1")
- 4 October 1957.



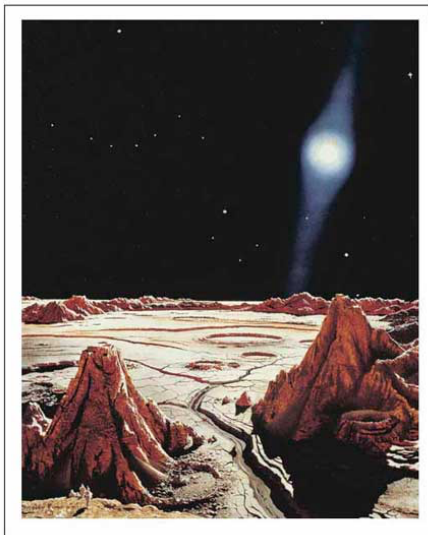
- Neil Armstrong/Buzz Aldrin 1969
- Apollo 11

"A Correction"
(New York Times July 17, 1969)

Further investigation and experimentation have confirmed the findings of Isaac Newton in the 17th century and it is now definitely established that a rocket can function in a vacuum as well as in an atmosphere. The Times regrets the error.

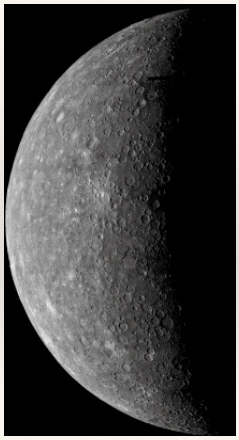
Mercury

Chesley Bonestell, *Surface of Mercury* (1947)

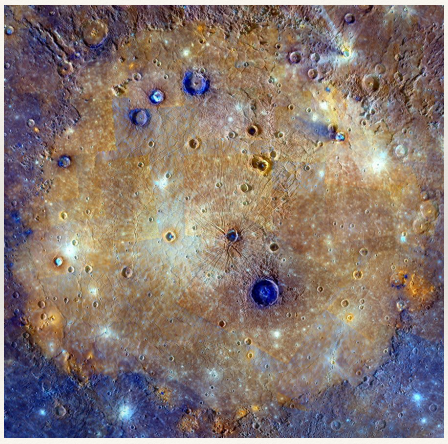


Mercury

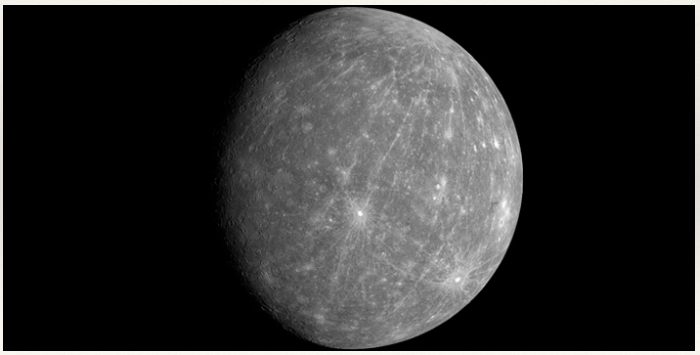
Always seemed to be really boring



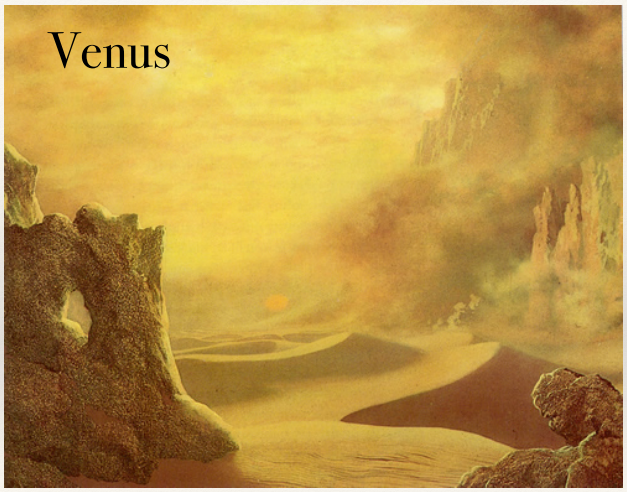
This is Caloris basin



- Fortunately NASA has sent Messenger to Mercury
- Started orbit in March 2011
- And it IS really boring



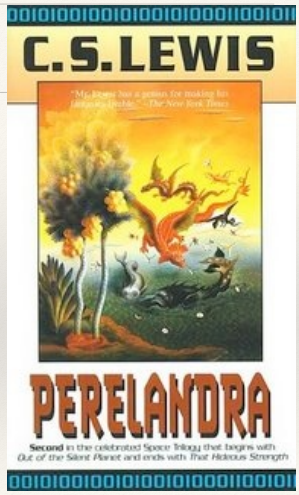
Venus



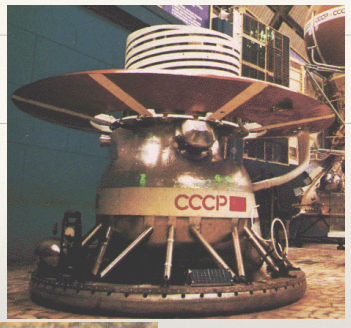
Chesley Bonestell, *Surface of Venus* (1947)

Venus

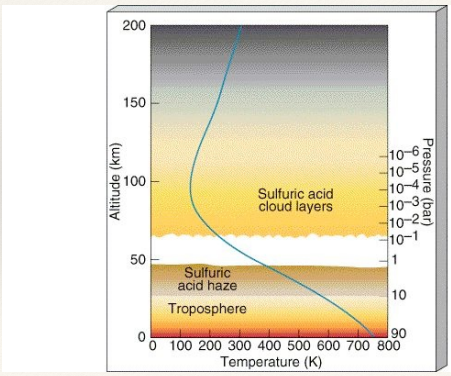
Popular with writers:
e.g C. S. Lewis
So does it look like this?



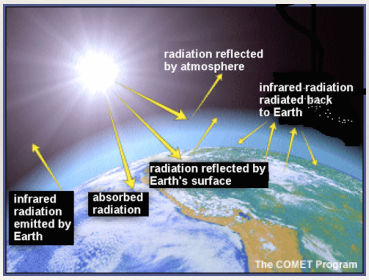
Venera 14

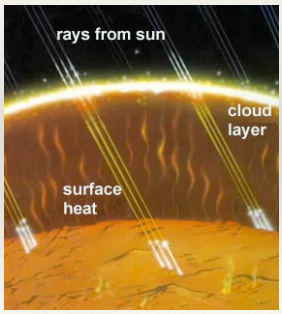


- Atmosphere very dense, mainly CO_2
- Upper clouds rotate in 4 days (~360 km/hr)
- At surface, gentle winds, but temperature ~ 700 °C



Why is "Earth's Twin" so utterly different?



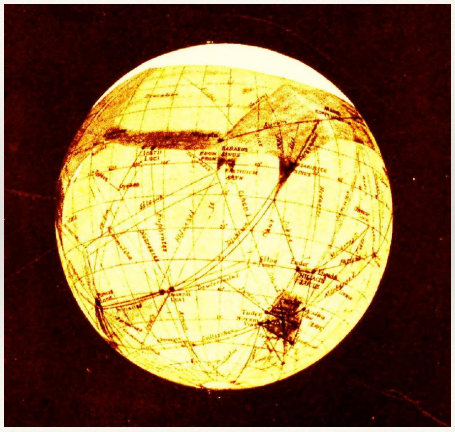


Mars

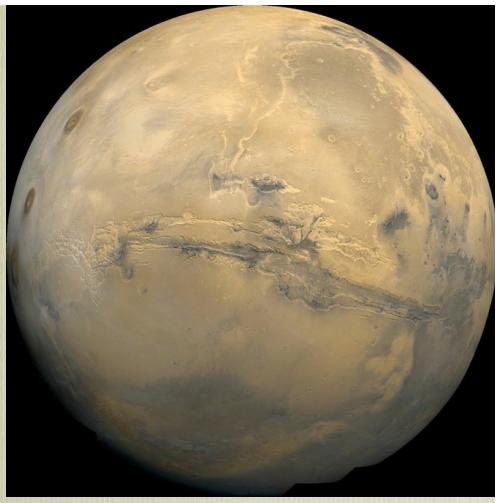
Chesley Bonestell, *The exploration of Mars* (1947)

Mars

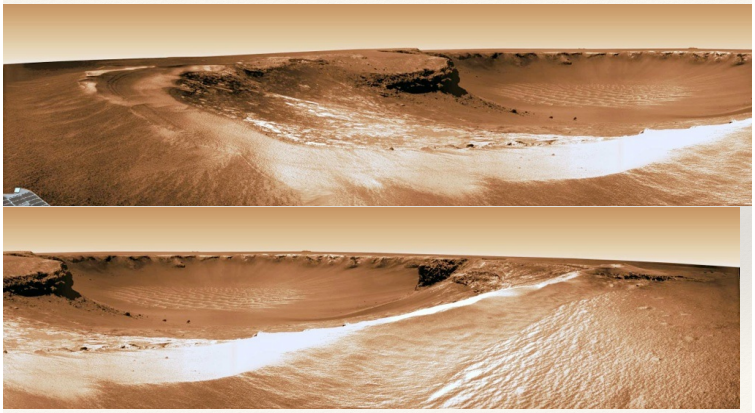
- Very popular with writers: Bradbury did it best ("Sands of Mars")
- Lowell observed canals



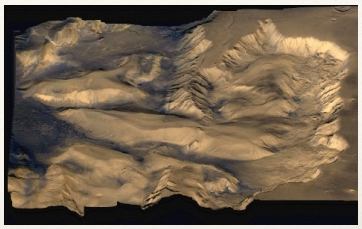
- Valles Marineris: the "Grand Canyon" of Mars
- 3000 km long
- Up to 600 km wide
- Up to 8 km deep

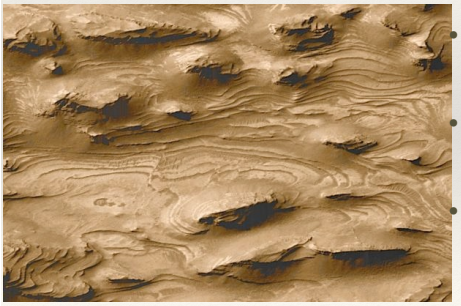


- Note the quality of pictures now: Victoria crater.
- Frost is frozen CO_2



Candor Chasma: Massive rift valley.

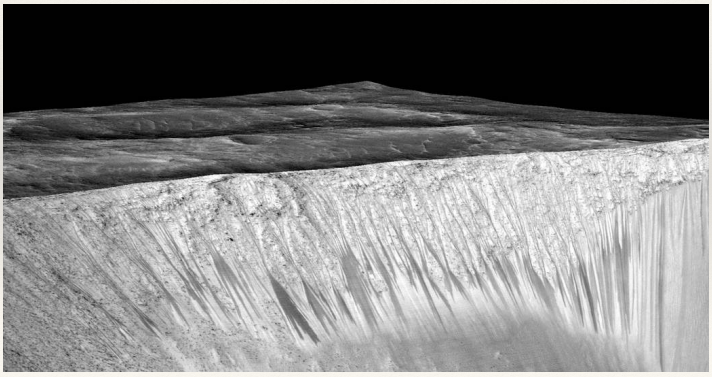




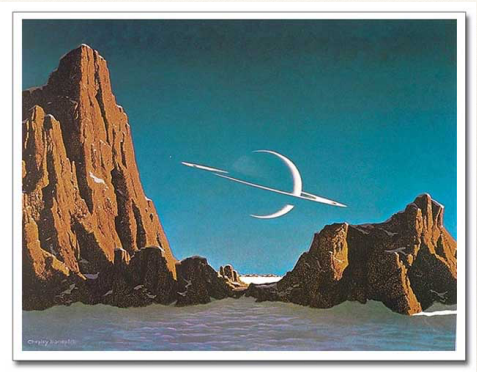
- The interesting problem:
- Does Mars have water?
- Some places looks just as though it once did

Lineae: briny water flows

Change darkness with the season

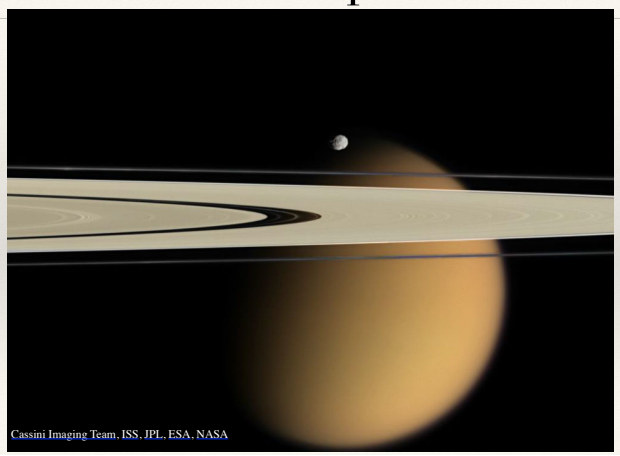


Saturn



Chesley Bonestell, *Saturn from Titan* (1947)

Titan with Epithemus

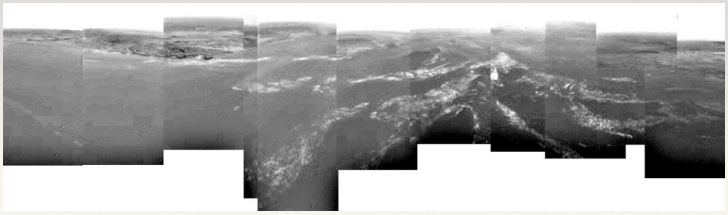


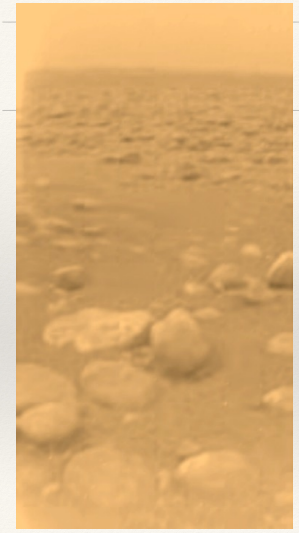
Titan

Larger than our moon, yellow atmosphere so surface invisible

Touchdown of probe: 14 January 2005,

The white streaks are 'fog' of methane or ethane vapour. Wind speed at 6-7 m/s.





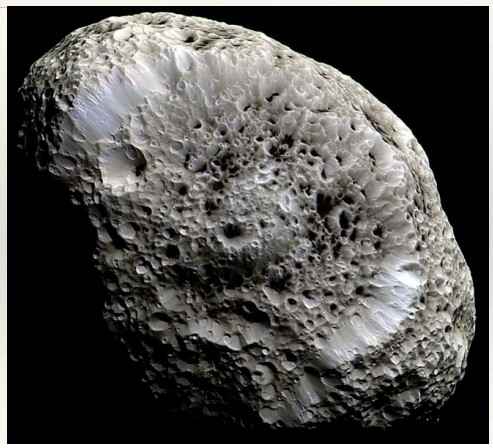
- Touch down at 4.5 m/s
- probe penetrated 15 cm.
- Surface consistency of wet sand or clay.

Methane rain

Hyperion

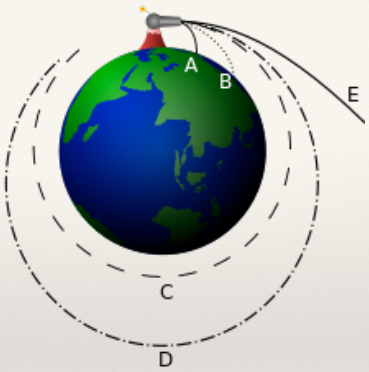
Density about 1/2 water (!)

suggests spongy texture!



Chesley Bonestell, *Saturn from Mimas* (1947)

But



- $v_{escape} \sim 11$ km/s
- $v_{orbit} \sim 7$ km/s (close to earth's surface)

- Means there is a minimum energy we must have to escape earth:
- e.g. for 1kg need at least 60 megajoules (roughly 3 litres of gas)
- but the 3 litres of gas weighs more than a kilogram .....

PW

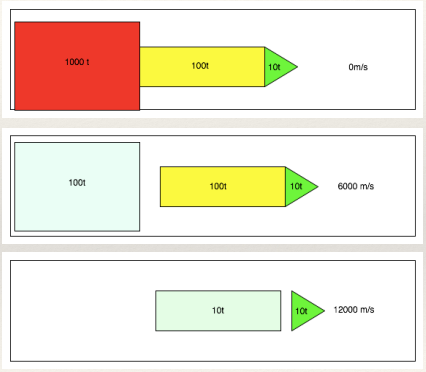
Suppose we could travel at the speed of light (300,000 km/s)

It would take
- An hour to get to Neptune
- 4 years to get to the closest star
- 50000 years to travel across our galaxy (the Milky Way)
- 1.5 million years to get to the next galaxy

But we cannot travel at the speed of light:
in practice we can achieve 50 km/s!

Rockets?

- Speed of rocket depends on exhaust speed.
- Suppose we have rocket with a mass of 100 tonnes, final mass 10 tonne, exhaust vel = 3000 m/s, final vel will be ~6000 m/s
- In practice need multi-stage rocket



Space Shuttle Atlantis

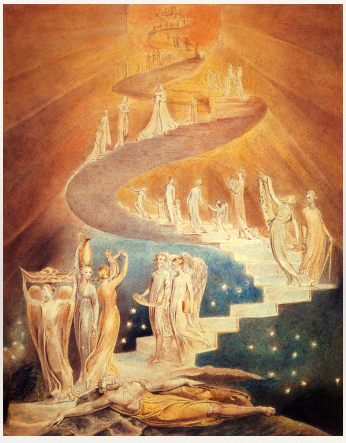
NASA

but on re-entry

- K.E. ~ 3 TJ = 3×10^{12}J
- **All** gets converted to heat
- Temp ~ 3000°C

Wikimedia

Genesis:28:10 And Jacob went out from Beersheba, and went toward Haran.
28:11 And he lighted upon a certain place, and tarried there all night, because the sun was set; and he took of the stones of that place, and put them for his pillows, and lay down in that place to sleep.
28:12 And he dreamed, and behold a ladder set up on the earth, and the top of it reached to heaven: and behold the angels of God ascending and descending on it.



May God bless and keep you always
May your wishes all come true
May you always do for others
And let others do for you
May you build a ladder to the stars
And climb on every rung
May you stay forever young
Forever young, forever young
May you stay forever young.

Bob Dylan

There's a lady who's sure all that glitters is gold
And she's buying a stairway to heaven.
When she gets there she knows, if the stores are all closed
With a word she can get what she came for.
Ooh, ooh, and she's buying a stairway to heaven.

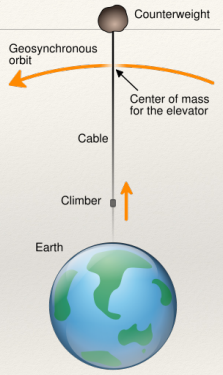
LED ZEPPELIN

- But assuming we are trying to get to synchronous orbit (36000 km), there are 144 million rungs
- if we can climb at 1 m /
- It takes us 1.2 y ng time)

Maybe we need an elevator!!!!!!!!

Space Elevator

- Still has energy problems (doesn't matter how we get something into orbit, energy is a constant).
- Need to be at geostationary orbit ~ 36000 km

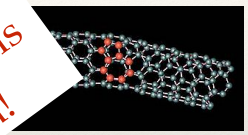


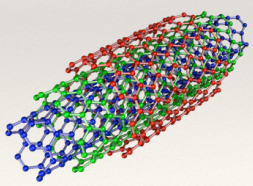
Wikimedia

- Needs materials with huge tensile strength and low density

Need	Strength	
	150 G	
Steel		
Kevlar		1000
Carbon nanotubes	(maybe!)	1000

But the longest nano-tube we can make is about 550 mm!





Text

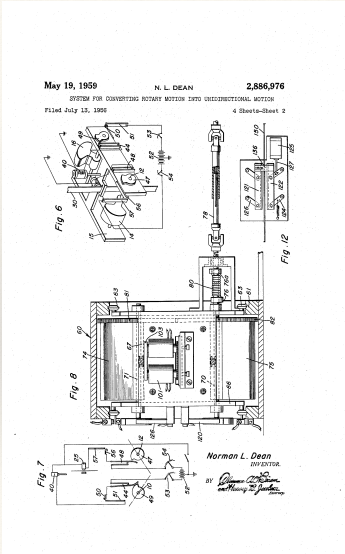
Reactionless drives

Taking a firm grasp on my pigtail, I lifted both myself and my noble horse from the morass

Baron Munchausen

sometimes called a "bootstrap"

Doré

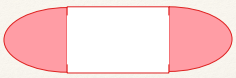


The Dean Drive

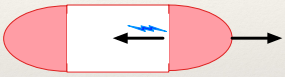
A device that converts asymmetric rotary motion into a force with no reaction

Another twist:

Space ship has laser at front



laser fires photon, ship recoils



photon absorbed, ship has moved forward

Reactionless drives

Taking a firm grasp o… pigtail, I lifted bo… my noble ho…

Baron …

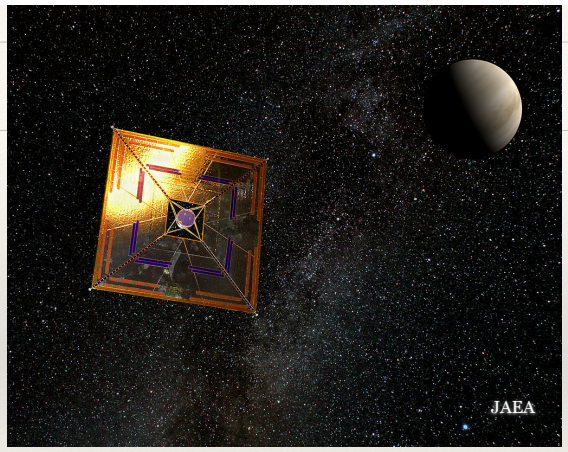
sometimes… "bootstrap"

except that the quote is totally fake, just like the drive!

Doré

No possible terrestrial power source can take us to the stars

- Could we use the sun?



- Radiation powered sailing ships!
- Wouldn't a solar sailing ship be romantic!!!!!!!!!!!!

- Need huge, very light sail: Say 1 km^2, 10 μ thick so very vulnerable to meteors etc
- Only works in space (so still need rocket to escape earth)
- Six months to get to the moon

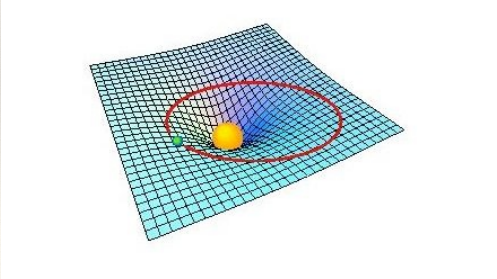
Back to Munchausen!

"a hurricane blew our ship at least one thousand leagues above the surface of the water,…. thus we proceeded above the clouds for six weeks. At last we discovered a great land in the sky, like a shining island, round and bright…"

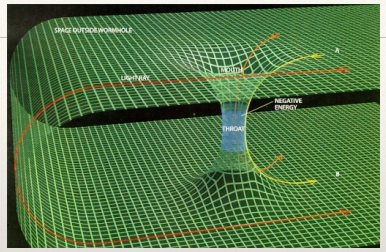
Rudolf Erich Raspe. "The Surprising Adventures of Baron Munchausen."

The Alcubierre Drive, or manifold-surfing for beginners

Massive bodies curve space,so planets are actually moving in "straight" lines in a curved space...

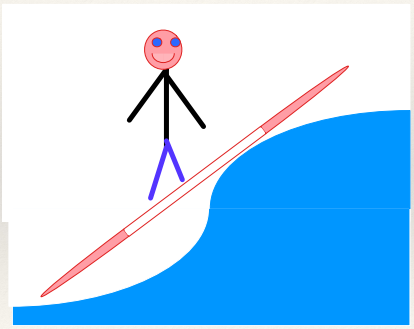


- Once we allow space to be bent, we can construct wormholes!

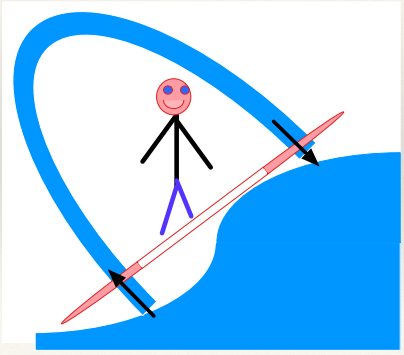


- Allow instantaneous communication across space
- (And innumerable stupid TV shows)
- But we need to find one, and it may not go where we want

- The Alcubierre drive: imagine a surfer riding a wave
- Like someone falling into a black hole

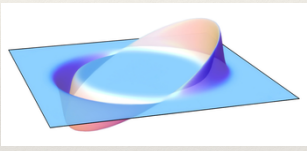


- But now imagine the surfer can pump up water in front, spill it out behind
- He can ride forever…..



$$ds^2 = \left(v_s(t)^2 f(r_s(t))^2 - 1\right) dt^2 - 2v_s(t) f(r_s(t))\, dx\, dt + dx^2 + dy^2 + dz^2.$$

$$-\frac{c^4}{8\pi G}\frac{v_s^2(y^2+z^2)}{4g^2 r_s^2}\left(\frac{df}{dr_s}\right)^2,$$



- You just need a bit of matter with negative mass to curve the space in the right way

But

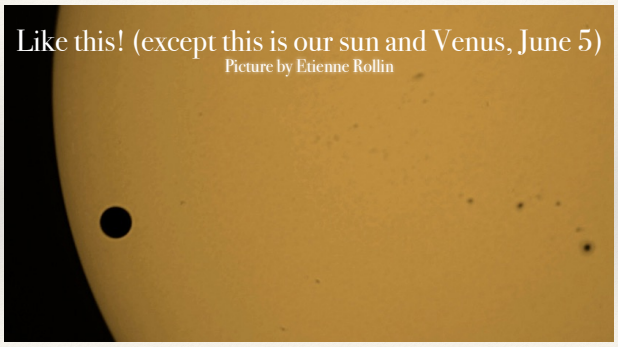
beware: in relativity, any method to travel faster than light can in principle be used to travel back in time (a time machine) Miguel Alcubierre

Finally

The (currently) weirdest object in the universe!

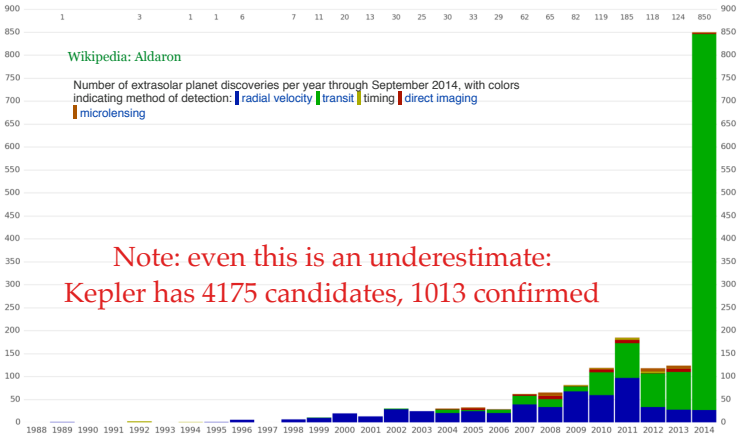
Exoplanet search

Now we are seeing lots of other solar systems



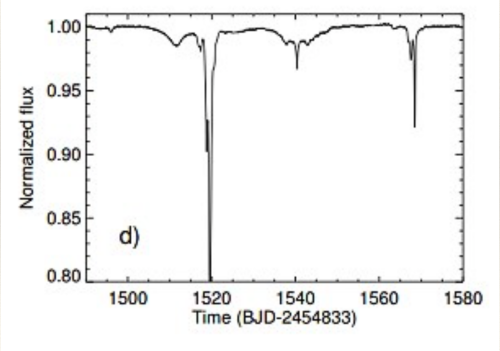
~ 0.01 % drop in brightness of sun

How many?



KIC 8462852 or WTF star ("Where's The Flux?")

Produces 20% change in output over a matter of a few days



Why?

Huge planet?

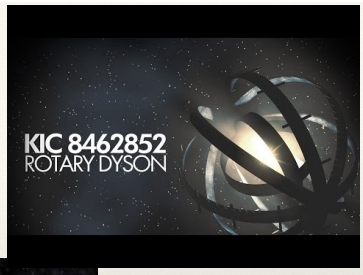
Alien megastructures?

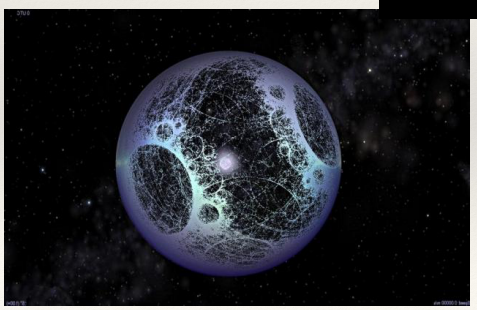
Black Hole?

Dark Star?

Huge cloud of comets?

Alien megastructures





Probably

Huge planet?

Alien megastructures?

Black Hole?

Dark Star?

Huge cloud of comets?

- Thanks to.. **Chesley Bonestell**
- NASA, APOD, JAEA, Wikimedia, Dick Hallion

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