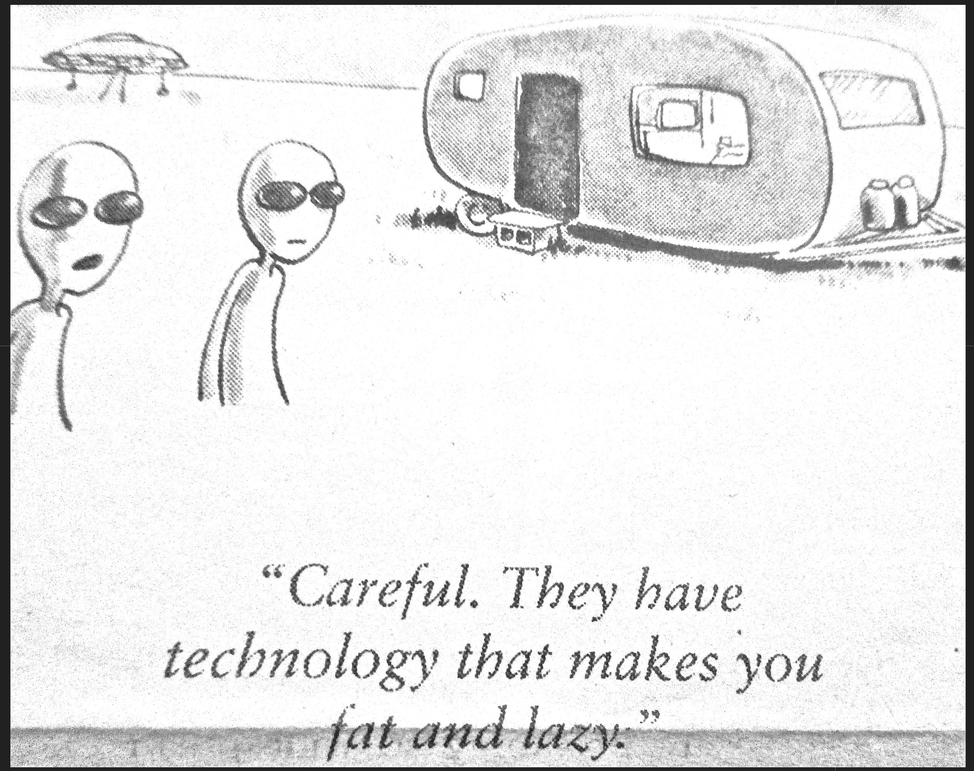
The Random Alien Test (RAT)



In RAT, the aliens show up randomly one day and ask a random earthling basic questions about the Universe that everyone knows. This is a test to see if we are worthy in 1900:

- **What is the Energy Source of Stars?**
- **Why does the Orbit of Mercury not obey Newton's Laws?**
- **What is the structure of the atom?**
- **Is light a wave or a particle?**
- **How does species evolution actually occur?**

IN 1905 we have a resolution to most of those questions:

$E= mc^2$ This is an Original Idea

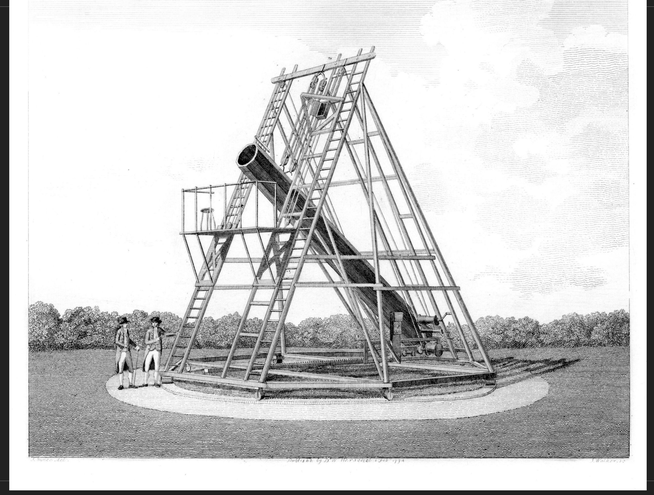
- Requires the speed of light to be finite
- Light has an energy related mass and is effected by gravity
- Mass can be converted to Energy → now we know how stars shine

This Idea Seems Ludicrous

- In a letter to a friend, Einstein writes:

" ...The relativity principle in connection with the Maxwell equations demands that the mass is a direct measure for the energy contained in bodies; light transfers mass... This thought is amusing and infectious, but I cannot possibly know whether the good Lord does not laugh at it and has led me up the garden path."

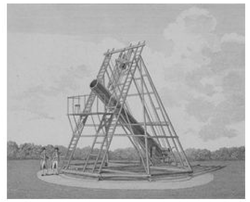
Why we know this works - this will be the only resolution of some new observed motion anamolies that can not be explained by Newton's laws.



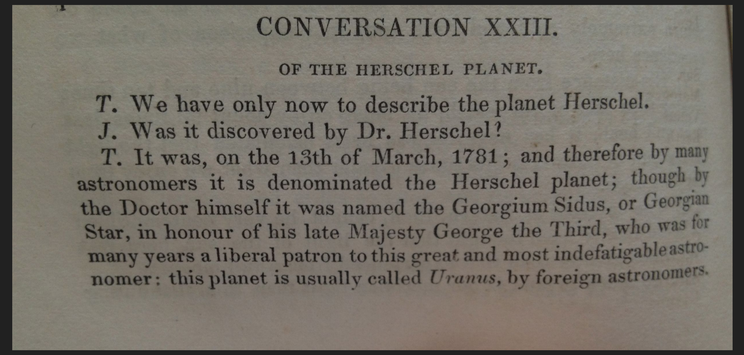
Science proceeds because of a new instrument. Herschel's telscope diameter of 49.5 inches is more than 2 times larger than any existing Telescope in the world. He becomes elite!

- Herschel in the 1780s studied the motions of double stars and showed that they obeyed Kepler's Laws

Why is this important?



By the 1820s it became evident that Uranus was not following its predicted orbit. What to do? Could Newton be wrong?



CONVERSATION XXIII.

OF THE HERSCHEL PLANET.

T. We have only now to describe the planet Herschel.

J. Was it discovered by Dr. Herschel?

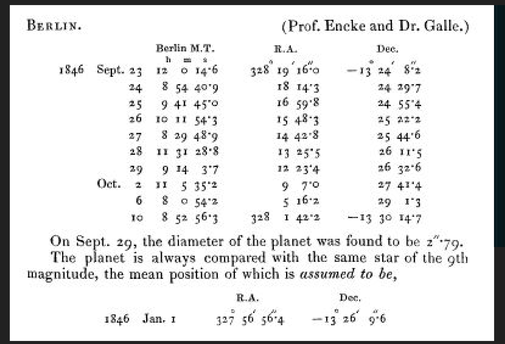
T. It was, on the 13th of March, 1781; and therefore by many astronomers it is denominated the Herschel planet; though by the Doctor himself it was named the Georgium Sidus, or Georgian Star, in honour of his late Majesty George the Third, who was for many years a liberal patron to this great and most indefatigable astronomer: this planet is usually called *Uranus*, by foreign astronomers.

...I leave it to the future the task of discovering whether the difficulty of reconciling [the orbital data] is connected with the ancient observations, or whether it depends on some foreign and unperceived cause which may be acting on the planet

---Bouvard 1821

In the 1840s, John Adams (England) and Urbain Le Verrier (France) independently hypothesized that the "foreign and unperceived cause" was an undiscovered planet and they each separately worked out its likely location based on the mathematical application of Newton's Laws

On Sept. 23, 1846, Johann Gall at the Royal Observatory in Berlin, pointed a telescope at the predicted postion and discovered this:



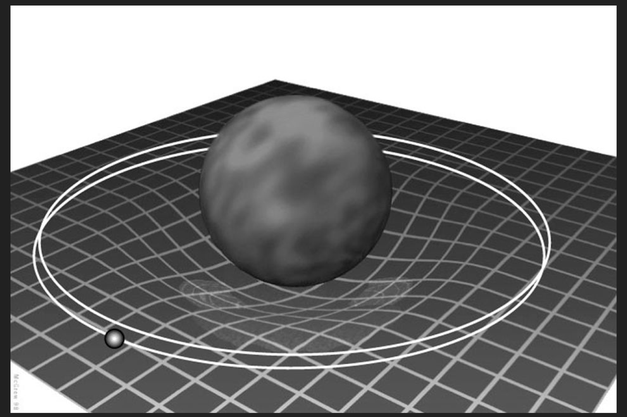
BERLIN. (Prof. Encke and Dr. Galle.)

		Berlin M.T. h m s	R.A. ° ′ ″	Dec. ° ′ ″
1846	Sept. 23	12 0 14·6	328 19 16·0	−13 24 8·2
	24	8 54 40·9	18 14·3	24 29·7
	25	9 41 45·0	16 59·8	24 55·4
	26	10 11 54·3	15 48·3	25 22·2
	27	8 29 48·9	14 42·8	25 44·6
	28	11 31 28·8	13 25·5	26 11·5
	29	9 14 3·7	12 23·4	26 32·6
	Oct. 2	11 5 35·2	9 7·0	27 41·4
	6	8 0 54·2	5 16·2	29 1·3
	10	8 52 56·3	328 1 42·2	−13 30 14·7

On Sept. 29, the diameter of the planet was found to be 2″·79.
The planet is always compared with the same star of the 9th magnitude, the mean position of which is *assumed to be*,

		R.A. ° ′ ″	Dec. ° ′ ″
1846	Jan. 1	327 56 56·4	−13 26 9·6

THE PROBLEM WITH MERCURY.

- Precision measurements in the 1840's and 1850's showed that the orbit of Mercury did not conform to Newtonian Mechanics. As in the case of Uranus, a suspected perturbing body was the likely explanation.
- However, in 1859, Levierre (the same guy involved in the discovery of Neptune) showed, using precision calculations, that this could not be the source of the observed anomaly in the orbit of Mercury.
- So what to do Dismiss the Anomaly or Dismiss Newton?
- What would Newton Say if presented these data?

Gravity = curvature of space-time; Mercury orbits in curved space due to its proximity to the Sun. Newton's space is always flat. Newton's theory is therefore incomplete.