Hooke and Newton:
The Story of Universal Gravitation

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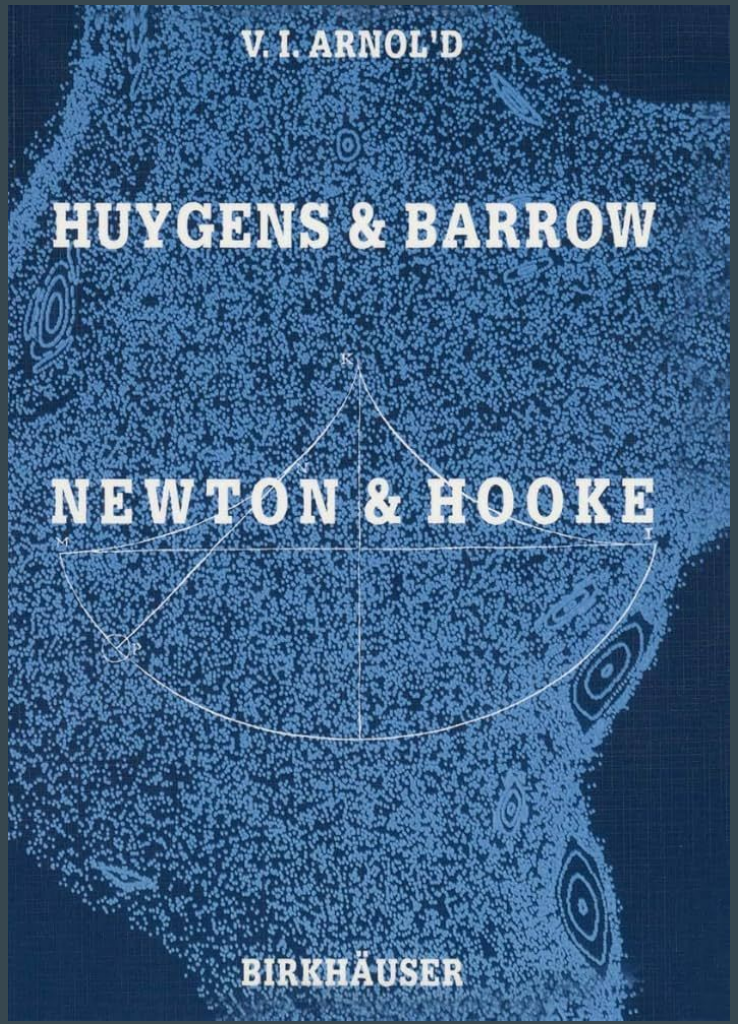
The Myth:

- Hooke: Poor, underappreciated scientist who had right intuition and developed many core ideas of gravitation

- Newton: Initially wrong about gravity. Took these ideas (making them rigorous), discredited Hooke, eventually destroyed portraits and private work of Hooke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Robert Hooke

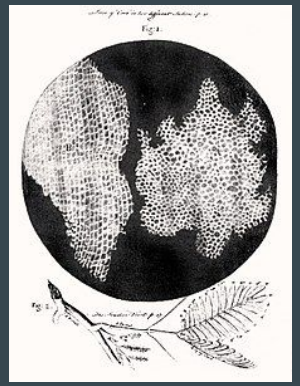
- Born relatively poor and sickly
- Worked his way up through various apprenticeships into science
- Was Robert Boyle's assistant, actually built and tested Boyle's law (P ~ 1/V)
- Landed position as curator at Royal Society: weekly tests/demonstrations of leading developments in science

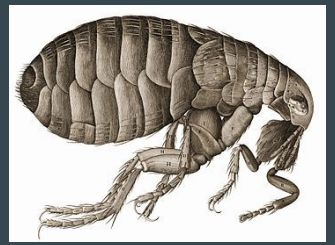
"He is but of midling stature, something crooked, pale faced, and his face but little below, but his head is lardge, his eie full and popping, and not quick; a grey eie. He haz a delicate head of haire, browne, and of an excellent moist curle. He is and ever was temperate and moderate in dyet, etc." - John Aubrey, contemporary

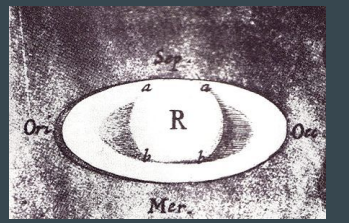
Some Contributions

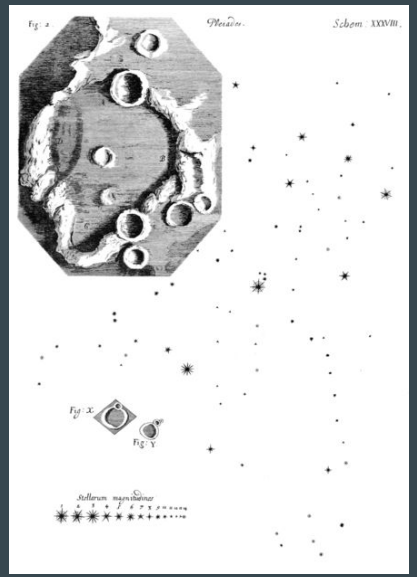
From later Royal Society librarian: “Without his weekly experiments and prolific work the Society could scarcely have survived, or, at least, would have developed in a quite different way. It is scarcely an exaggeration to say that he was, historically, the creator of the Royal Society.” - Henry Robinson

- Eye of Jupiter
- Coined term “cell”
- Radical ideas in geology, fossils
- Microscopes & telescopes
- Meteorology
- Expansion & heat
- Hooke’s law









Personality and Conflict

- Not a great impression left on contemporaries, reportedly quite difficult person
- “...if one studies the intellectual milieu of the time, the controversies and rivalries of the type in which he was involved seem almost to be the rule rather than the exception. And Hooke's reaction to such controversy involving his own discoveries and inventions seems mild in comparison to the behaviour of some of his contemporaries” - Ellen Drake, biographer
- Initially friendly with Newton, “shoulders of giants” in one such exchange
- Turned sour over debates on light (wave vs particle)

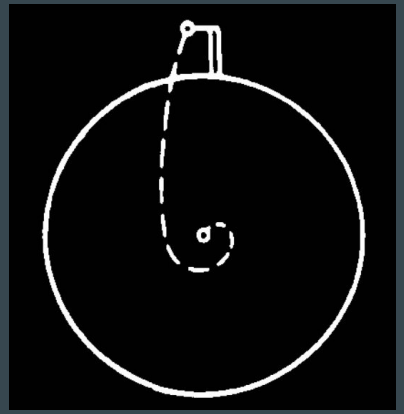
State of Gravitation pre-1679

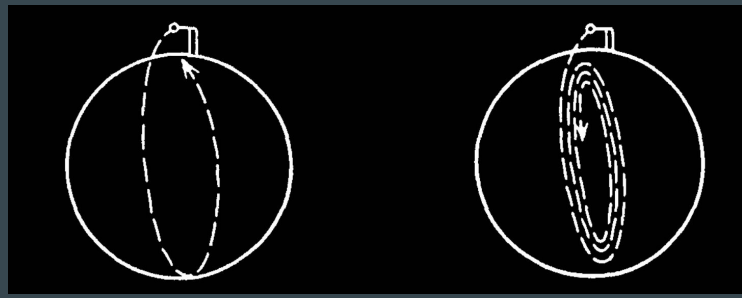
- Newton: two leaps (mid 1660s, 1680s with Principia). Regarding gravity, had argued Kepler's laws apply outside just planets, and showed inverse square law followed from circular orbits

- Hooke: close to universal gravitation (celestial bodies), gravitational central attraction, eventually fell in with inverse square law (increasingly prevalent). Reported analogue integrator, making "ellipsoid" shapes

1679 Letter

- Hooke began managing Royal Society correspondence, reached out to Newton for thoughts on gravity. Mentioned inverse square law, and attractive inwards force (plus tangential velocity)
- Newton mentioned he moved away from natural philosophy, but proposed an experiment to demonstrate earth's rotation (involving dropped weight). Furthermore, proposed idea of what happens if weight continued through Earth
- Hooke gave correct prediction, based on pendulum behaviors underground





The Experiment

- Dropped ball high above surface has higher rotational velocity, should fall further
- Suggested experiment, using two spherical weights from small effect
- Real effect not measurable at the time
- Hooke dropped from cathedral 3 times, and called it a day

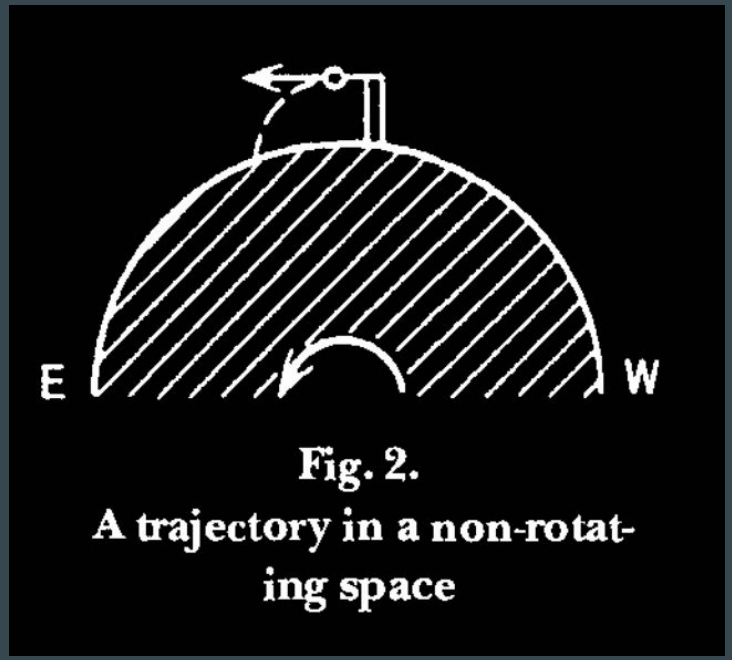
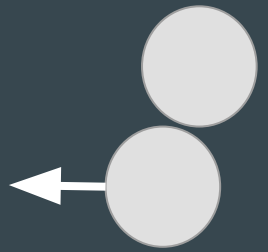
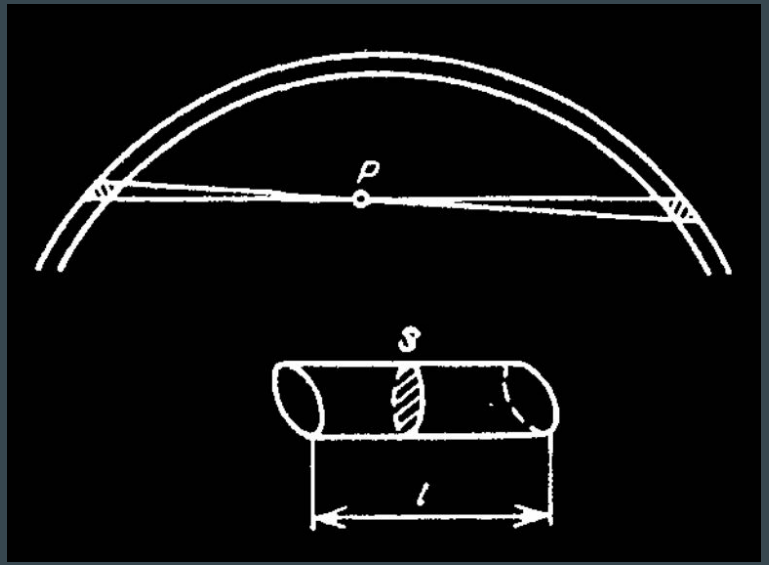


Fig. 2.
A trajectory in a non-rotating space



Newton and Principia

- Newton finished Principia in 1686, submitted to Royal Society. Included Hooke (amongst others) for some ideas in gravity (perhaps required addition from Royal Society).
- Hooke claimed Newton stole inverse square law from his letters. Modern stance is that Newton likely had enough evidence from community plus his own work to draw conclusions on his own



A Note on Newton's Ideas

- Several mathematicians (Arnold, Penrose, Needham) have argued elegance of Newton's geometric methods in Principia over typical calculus techniques:

people like Barrow, Newton and Huygens would have solved in a few minutes *(8)* and which present-day mathematicians are not, in my opinion, capable of solving quickly*: to calculate

$$\lim_{x \to 0} \frac{\sin \tan x - \tan \sin x}{\arcsin \arctan x - \arctan \arcsin x}.$$

Epilogue

- Newton became president of Royal Society in 1703 (year of Hooke's death)
- Evidence for Hooke's portrait existing, moves Society and poor bookkeeping could be to blame
- Private writing and notes also missing
- Popular story (considered unlikely, with no direct evidence) Newton ordered destruction of Hooke's work and portrait

That’s all, thanks!

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