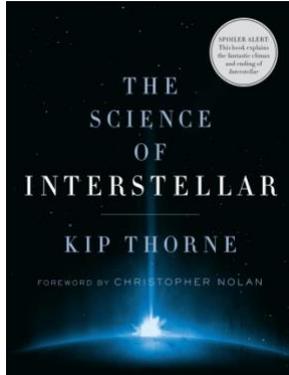


The Movie *Interstellar*: The Science Behind the Story – notes by Andrew Fraknoi

The scientific advisor of the film *Interstellar* (and one of its producers) was Prof. Kip Thorne of Caltech, who is arguably the world's expert on black holes -- and who designed the "galactic subway system" in Carl Sagan's novel and film *Contact* and received the Nobel Prize in physics in 2017. He has written a book, entitled *The Science of Interstellar*, to explain the complicated ideas behind some of the more intriguing scenes and events in the film. It also tells the history of the film, which was always strong on science, and was once set to be directed by Stephen Spielberg – but that arrangement fell apart.



With Christopher Nolan and his brother Jonathan (a writer of screenplays) involved, the film quickly evolved from the simpler script Dr. Thorne and producer Lynda Obst had first envisioned, to include not just black holes, but more about a future Earth facing ecological disaster. Still, the original desire to show black holes as accurately as science can describe it was on everyone's list of priorities.

A black hole is a place where the death and collapse of a huge star has produced such strong gravity, that space itself is "warped" -- and nothing, not even light can escape. Near a black hole, time proceeds more slowly than in the rest of the universe, and this change in the flow of time becomes a major plot element in the movie. Both the existence of black holes and their strange effect on time have been demonstrated by many experiments and are well established.

A wormhole is more speculative, but something Einstein himself thought a bit about. It's a place where a black hole or some other unusual feature of space and time becomes a tunnel (or short cut) from one place in space to another place very far away, or even to another time. In a "practical wormhole," (which many scientists doubt can exist in nature) the dangerous effects that you would feel falling into a black hole are somehow kept at bay, so that a spaceship can go through it to elsewhere or elsewhen undamaged. Such "easy" wormholes have become a staple of science-oriented science fiction, when the plot requires instant travel through space.

Both wormholes and black holes get major roles in *Interstellar*. The astronauts in the movie first use a wormhole to get from our Milky Way Galaxy to another galaxy far, far away. They wind up in that other galaxy at a location where there is a massive, spinning black hole, with planets around it. The black hole has an "accretion disk" (a region of swirling, energetic material) some distance away, which shines with light similar to our Sun, giving the planets light and some warmth. I won't give anything else away, except to say that the special effects showing the wormhole and the gargantuan black hole were composed from calculations made by Dr. Thorne and his team at Caltech, fed directly to the computers of the special effects team for the movie – and they are truly SPECTACULAR.

For more, I recommend reading Dr. Thorne's book. Dr. Thorne also has a web page with some animations at: <https://interstellar.withgoogle.com/transmissions> Or see: 1) Lee Billings: Parsing the Science of Interstellar with Physicist Kip Thorne: <http://blogs.scientificamerican.com/observations/parsing-the-science-of-interstellar-with-physicist-kip-thorne/> or 2) Adam Rogers: Wrinkles in Spacetime: The Warped Astrophysics of Interstellar: <http://www.wired.com/2014/10/astrophysics-interstellar-black-hole/all/1>

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