Twitter Thread by Phil Plait

Phil Plait
@BadAstronomer

1/ Today is #BlackHoleFriday, an annual science outreach event that, by complete coincidence I'm sure, is done on #BlackFriday. You'll read lots of cool stuff about black holes on the hashtag. Here's mine.

2/ Black holes are weird. Duh. People like to think of them as something like incredibly dense nuggets of stuff that sucks other stuff in. But they're not like that.

3/ If you squeeze enough mass into a small enough volume, the gravity gets so intense that it's impossible to escape them *if you get too close*. From far away, though, gravitationally they more or less act like anything with that much mass.

4/ So if the Sun turns into a black hole we wouldn't get drawn in. In fact, we'd orbit it almost exactly the same way as we do now, though we'd freeze to death pretty rapidly, which, in the end, would still kinda suck.

5/ Black holes get weird *when you get close*. Anything with mass warps space — we feel that warp as gravity! — but black holes stretch space to its limit.

6/ It's like falling down an infinitely deep hole with perfectly vertical and frictionless sides. Down you go, and that's that. Even light can't get out if it gets too close.

7/ But because they warp space so much, there are weird effects. Take, for example, the size of a black hole. Imagine an infinitely deep circular hole in the ground. Literally bottomless. What's the hole's radius?

8/ Well, if you walk around it it has a circumference. Divide by 2 pi and you get the radius. But now try to go *through* it, down the hole and back up. You'd have to travel forever. The radius in that sense is ∞.

9/ I know, right? It gets weirder. A black hole in general is a sphere. That means you can measure the radius by going around it. How does that depend on mass?

10/ Turns out, if you double the mass of a black hole, you double the radius (see: https://t.co/jIYeYG3THl). That's the way the math works out. BUT think about geometry. The volume of a sphere goes up as the radius CUBED.

11/ So when you double the mass of a black hole, the volume goes up by 2 x 2 x 2 = 8 times. That leads to an interesting idea. Density is mass / volume. What happens to a black hole's overall density as it consumes material?

12/ Double the mass and the volume goes up by 8. That means the density goes DOWN by 2/8 = a factor of 4. As a black hole gets more massive *its density gets lower*. 10 times the mass = 1/100th the density.

13/ At some point a black hole gets so big its density becomes very small. A black hole with 4 billion times the Sun's mass would have a diameter of 24 billion km (big!) but have the density of… air.

14/ In other words, if you took a sphere 24 billion km across and filled it with *air* at Earth's sea level density, it would be so massive it would be a black hole.

15/ Mind you, we see some black holes this massive! They're in the centers of distant galaxies, but still. They exist. Supermassive, but very low density.

16/ Come to think of it, they'd float if you had a bathtub big enough. And could keep the water from collapsing into a black hole. And had a uniform 1g gravitational field under it to counteract buoyancy. Hmm. This idea has issues. I'll have to write more about it some day.

17/ Anyway, I had a conversation with a leading black hole physicist some years ago, and mentioned this to him. He got thoughtful, and then nodded. "Yeah," he said. "That's right!" I was pretty chuffed to a) be right, and 2) have thought of something he hadn't thought of.

18/18 Honestly, I wondered if I had missed something obvious, but nope. This is correct. So, to summarize: Black holes are weird. And that's my #BlackHoleFriday thread. /fin

19/18 (yeah, I know) BTW here's my Crash Course Astronomy episode on black holes.

https://t.co/QetnodyE72

#BlackHoleFriday