BBC

TOO FAST: THE SHOES BANNED AT THE OLYMPICS

Science Focus

THE BIG QUESTIONS SPECIAL ISSUE

Do we live in a simulation?

How did life begin?

Should we play with evolution?

Are we getting happier?

What happens when we die?

Should we reach out to aliens?

Is religion dying out?

What are emotions?

What's inside the fifth dimension?

Can we cure old age?

SF
SCIENCEFOCUS.COM
#366 SUMMER 2021
US $11.50 CANADA $13.99

IN THIS ISSUE

Icy plunge
Why doctors think you should try cold-water swimming

Dragon man
Meet the long-lost member of the human family

Artificial heart
A machine-based transplant Iron Man would be proud of

SPACE

Supermassive black holes may be formed by collapsing dark matter halos

The theory may help to explain the presence of supermassive black holes in the early Universe

Supermassive black holes (SMBHs) are thought to be lurking at the centre of every galaxy, but very little is known about their origins. Current thinking suggests that these cosmic behemoths, which can have masses millions of times that of the Sun, would grow relatively slowly as it would take a considerable amount of time for them to suck in the matter that surrounds them.

There must be something else going on, however, as several supermassive black holes have been observed that date back to the early days of the Universe.

Now, physicists at the University of California think they may have an explanation: seed black holes, or black holes in their initial stages, can be formed by the collapse of the dark matter halos that surround galaxies.

"Physicists are puzzled why SMBHs in the early Universe, which are located in the central regions of dark matter halos, grow so massively in a short time," said study leader Hai-Bo Yu, an associate professor of physics and astronomy at the University of California Riverside, who led the study. "It's like a five-year-old child that weighs, say, 200lbs [90kg]. Such a child would astonish us all because we know the typical weight of a newborn baby and how fast this baby can grow. When it comes to black holes, physicists have general expectations about the mass of a seed black hole and its growth rate. The presence of SMBHs suggests these general expectations have been violated, requiring new knowledge. And that's exciting."

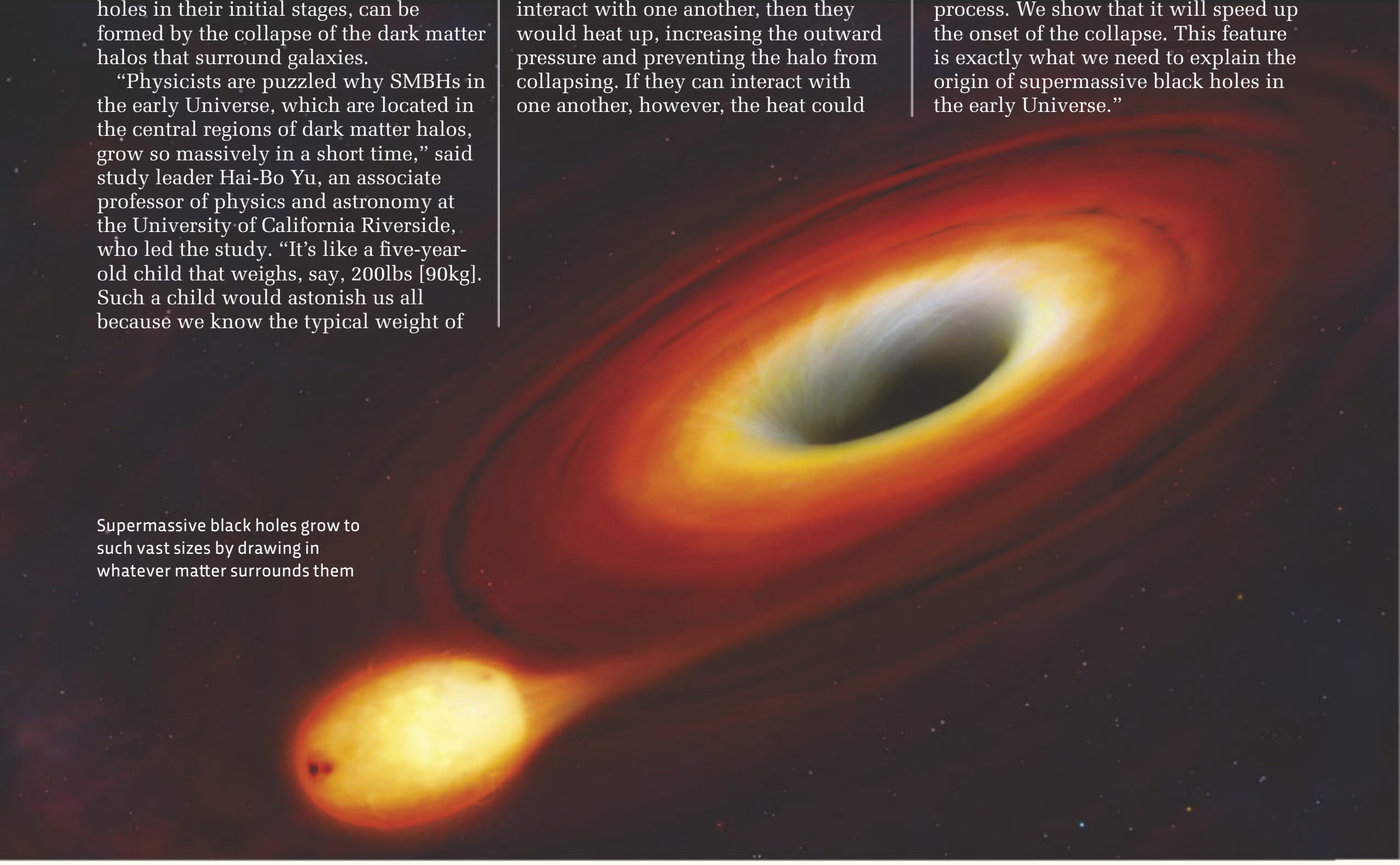
According to Yu's theory, the halo is initially formed as gravity pulls particles of dark matter closer and closer together. As the halo continues to form, a battle begins between gravity, which is pulling the particles into the centre of the halo, and pressure, which is pushing them outwards.

If the dark matter particles can't interact with one another, then they would heat up, increasing the outward pressure and preventing the halo from collapsing. If they can interact with one another, however, the heat could be readily distributed throughout the particles leading to the halo's eventual collapse and the formation of a seed black hole.

This seed can grow more massive by sucking in any surrounding baryonic (visible) matter such as gas and stars.

"The advantage of our scenario is that the mass of the seed black hole can be high since it's produced by the collapse of a dark matter halo. Thus, it can grow into a supermassive black hole in a relatively short timescale," said Yu.

"In many galaxies, stars and gas dominate their central regions. Thus, it's natural to ask how the presence of this baryonic matter affects the collapse process. We show that it will speed up the onset of the collapse. This feature is exactly what we need to explain the origin of supermassive black holes in the early Universe."



Supermassive black holes grow to such vast sizes by drawing in whatever matter surrounds them