The Hunt for the First Black Holes in the Universe

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The Final Destination

TRAILER: What is a black hole?
How do black holes form?

What kind of black holes are out there?

How did the first black holes in the Universe form?

Why are they important for the evolution of the Universe?
Escape velocity

Launch of the spacecraft New Horizons towards Pluto
Escape Velocity

\[ V_f \]

6.8 mi/s = 25 000 mi/h

37 mi/s = 134 000 mi/h

EARTH

JUPITER
What is a black hole?

For a black hole: 

\[ V_f \geq 186000 \text{ mi/s} \]
Identity card for a black hole

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<th>Field</th>
<th>Details</th>
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<td>Cognome</td>
<td>Black</td>
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<td>Logo</td>
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*Note: The fields for Cognome, Nome, nato il, (atto n, P, S), a, Cittadinanza, Residenza, Via, Stato civile, Professione, Statura, Capelli, Occhi, Segni particolari are left blank.*

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*Il Sindaco*

*Impronta del dito indice sinistro*

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*Firma del titolare:*

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*Il*

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The mass of a black hole

The mass determines:

- Dimension: 870,000 miles
- Category: 1.9 miles
The mass of a black hole

The most massive black hole ever discovered
The spin of a black hole
How can we observe them?
How can we observe them?
How are black holes formed?

**FORMATION**

**EVOLUTION OF STARS**

- Stellar Cloud with Protostars
- Large Star
- Red Supergiant
- Red Giant
- Planetary Nebula
- White Dwarf
- Supernova
- Neutron Star
- Black Hole

*Images not to scale*
Family portrait of black holes

Observed Mass Ranges of Compact Objects

- Stellar Black Hole
- Intermediate Mass Black Hole
- Supermassive Black Hole

This process requires a very long time

These are “classic” black holes
Object Mass (Relative to the Sun)
These are found at the center of galaxies
A brief history of Time

The first black holes formed here

First giant black holes

Peak of black hole activity

2 billion years

1 billion years

Now (13.7 billion years)
A “terrestrial” comparison

One day

The day after

Something must be wrong...
Too big, too soon

Observations of super-giant black holes < 1 billion years after the Big Bang
How did they grow up so rapidly?

Heavy black hole
100,000 M☉

Normal black hole
100 M☉

ULAS J1120+0641
z = 7.085

500 million years
Black holes and galaxies

Milky Way

12 times the Milky Way

M87
The building blocks of the Universe
The building blocks of the Universe
My research

- Predicts the light emitted by the first black holes
- Identified two black hole seed candidates