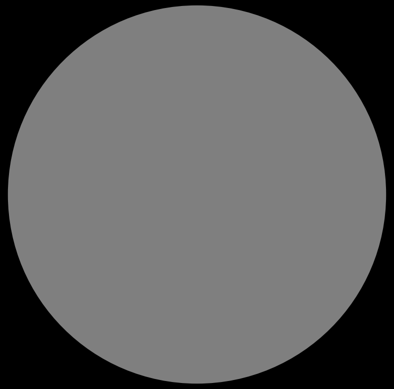
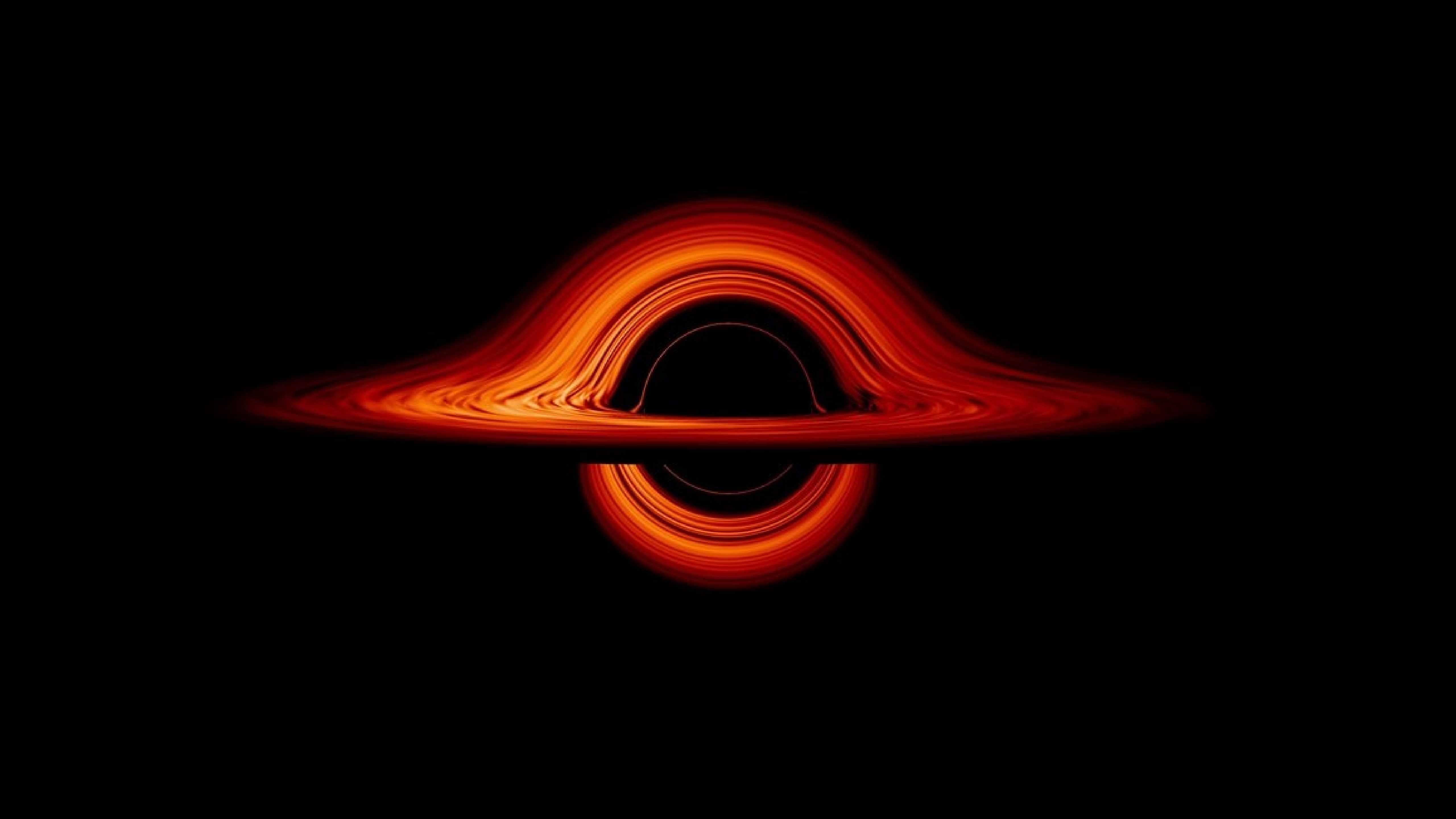
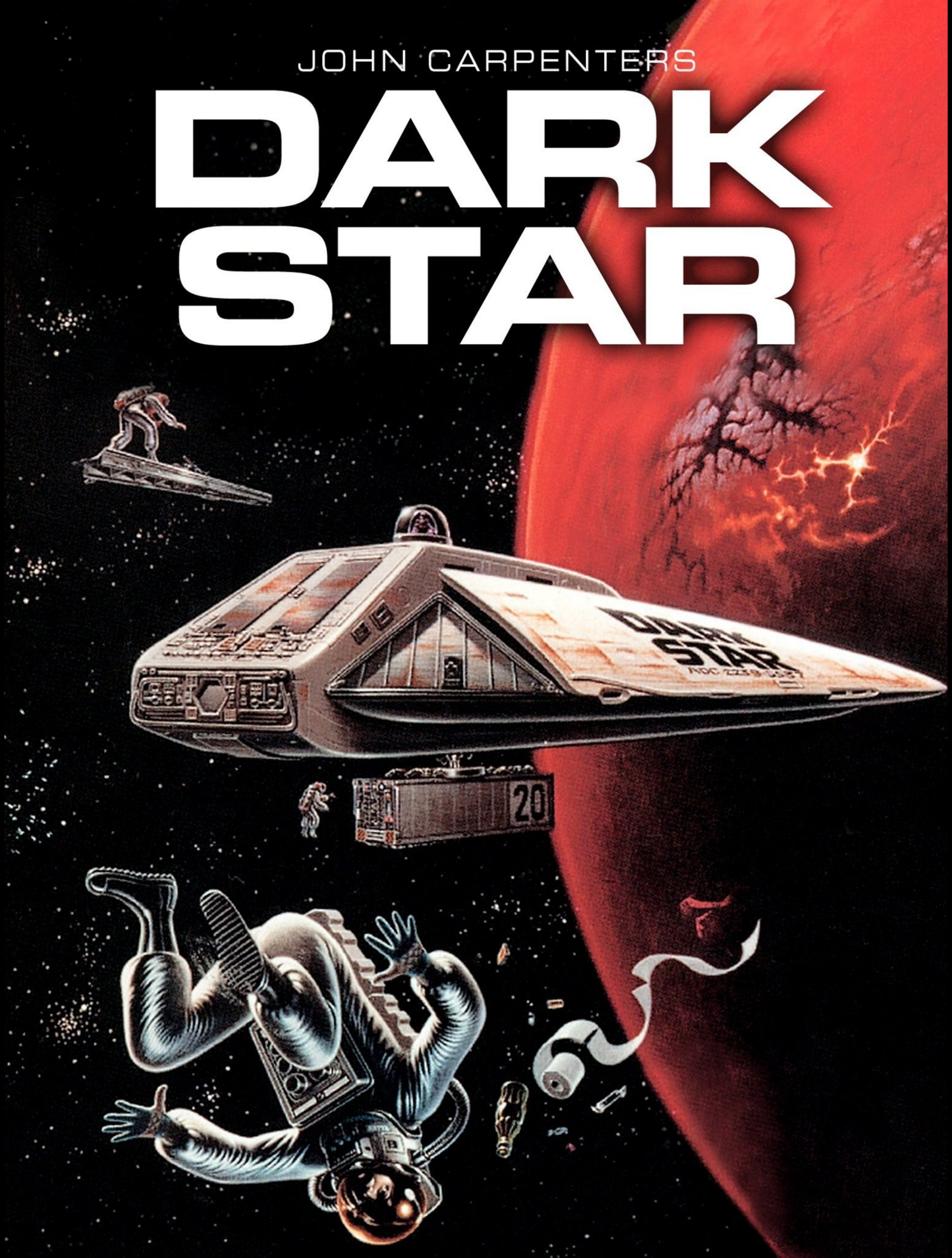



A/Hubble, Digitized Sky Survey, Nick Risinger, N. Bartmann



História


JOHN CARPENTERS
DARK
STAR
DARK
STAR
20

Temná hviezda

John Michell

Temná hviezda

John Michell

Henry Cavendish

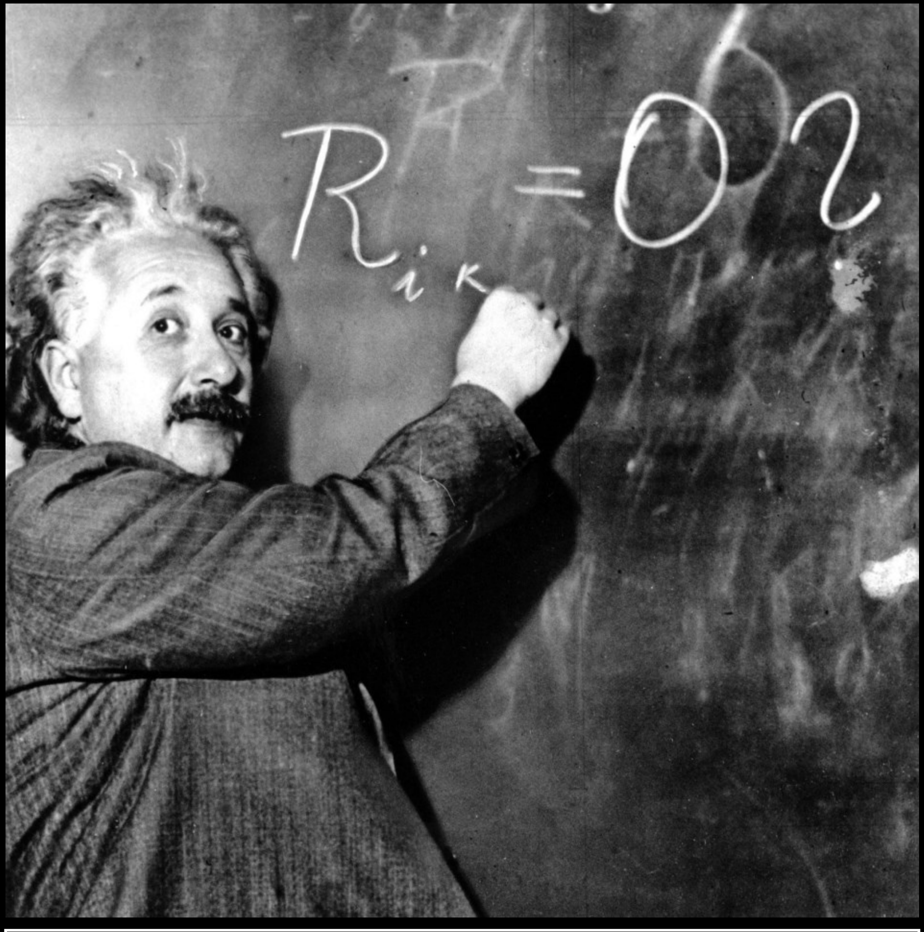
Temná hviezda

John Michell

Henry Cavendish

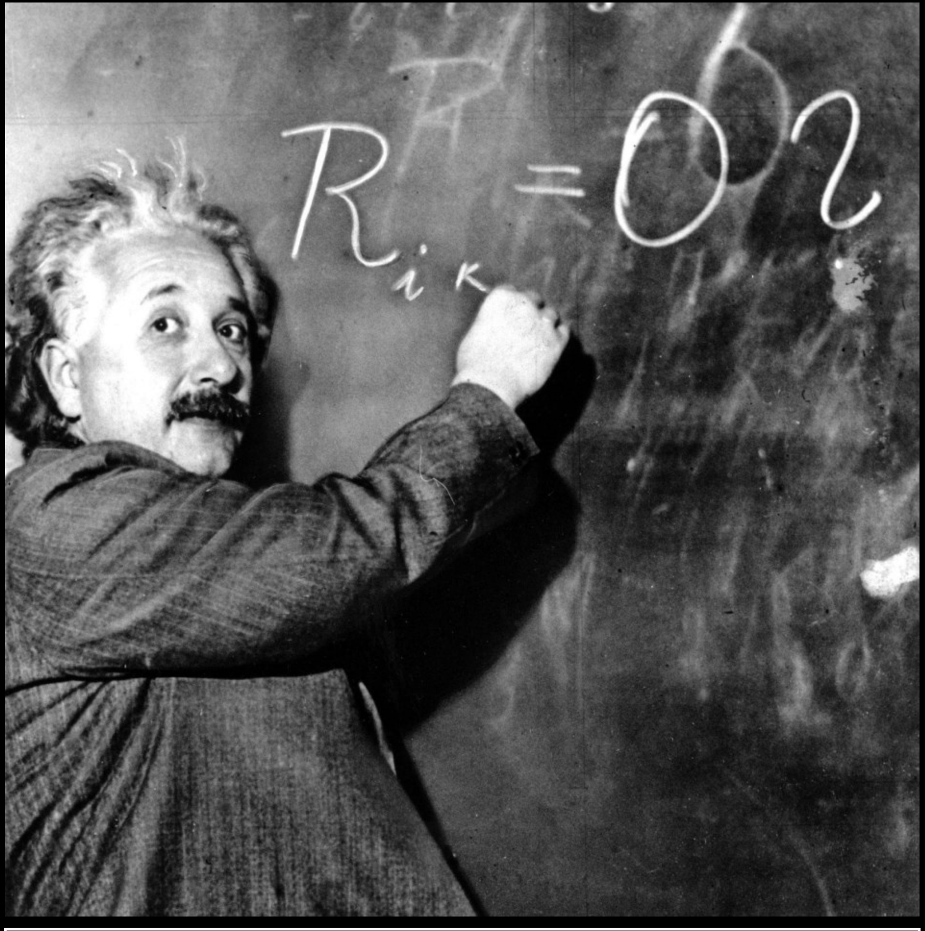
If the semi-diameter of a sphere of the same density as the Sun were to exceed that of the Sun in the proportion of 500 to 1, a body falling from an infinite height towards it would have acquired at its surface greater velocity than that of light, and consequently supposing light to be attracted by the same force in proportion to its vis inertiae, **all light emitted from such a body would be made to return towards it by its own proper gravity.** ith other bodies, This assumes that gravity influences light in the same way as massive objects.

Všeobecná teória relativity



Albert Einstein

Všeobecná teória relativity – prvé riešenie



Albert Einstein

Karl Schwarzschild

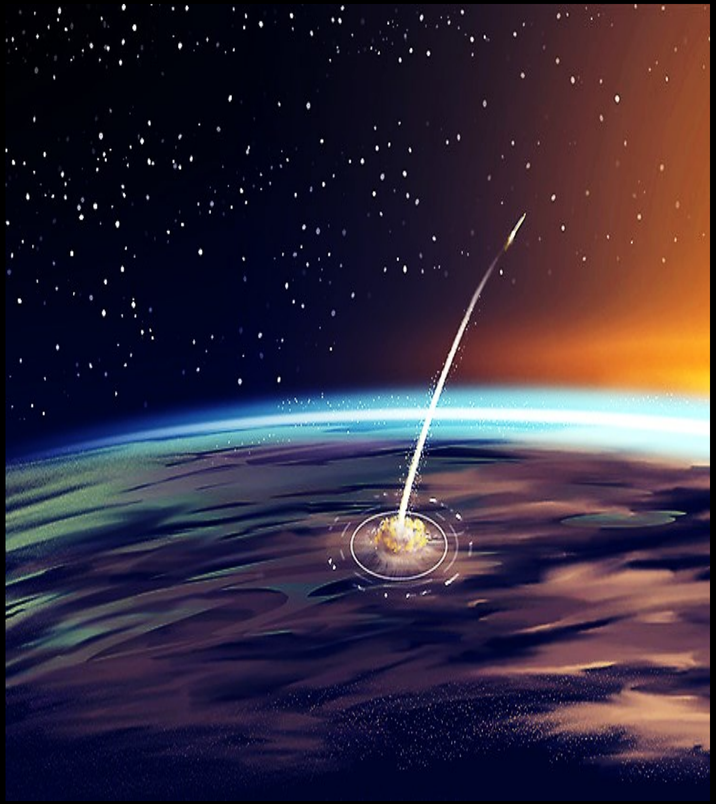
Všeobecná teória relativity – prvé riešenie

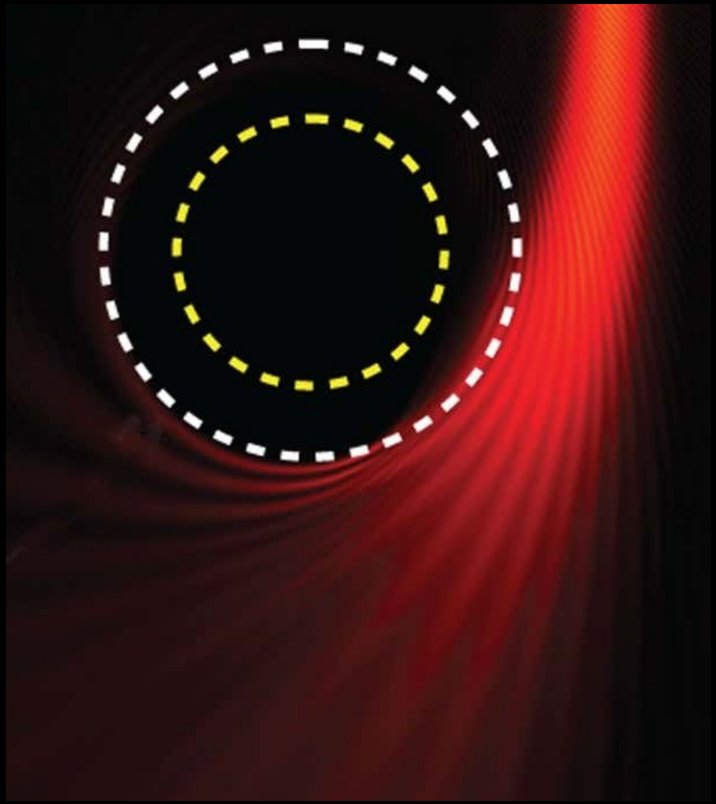
Karl Schwarzschild

Nemecké zákopy WWI

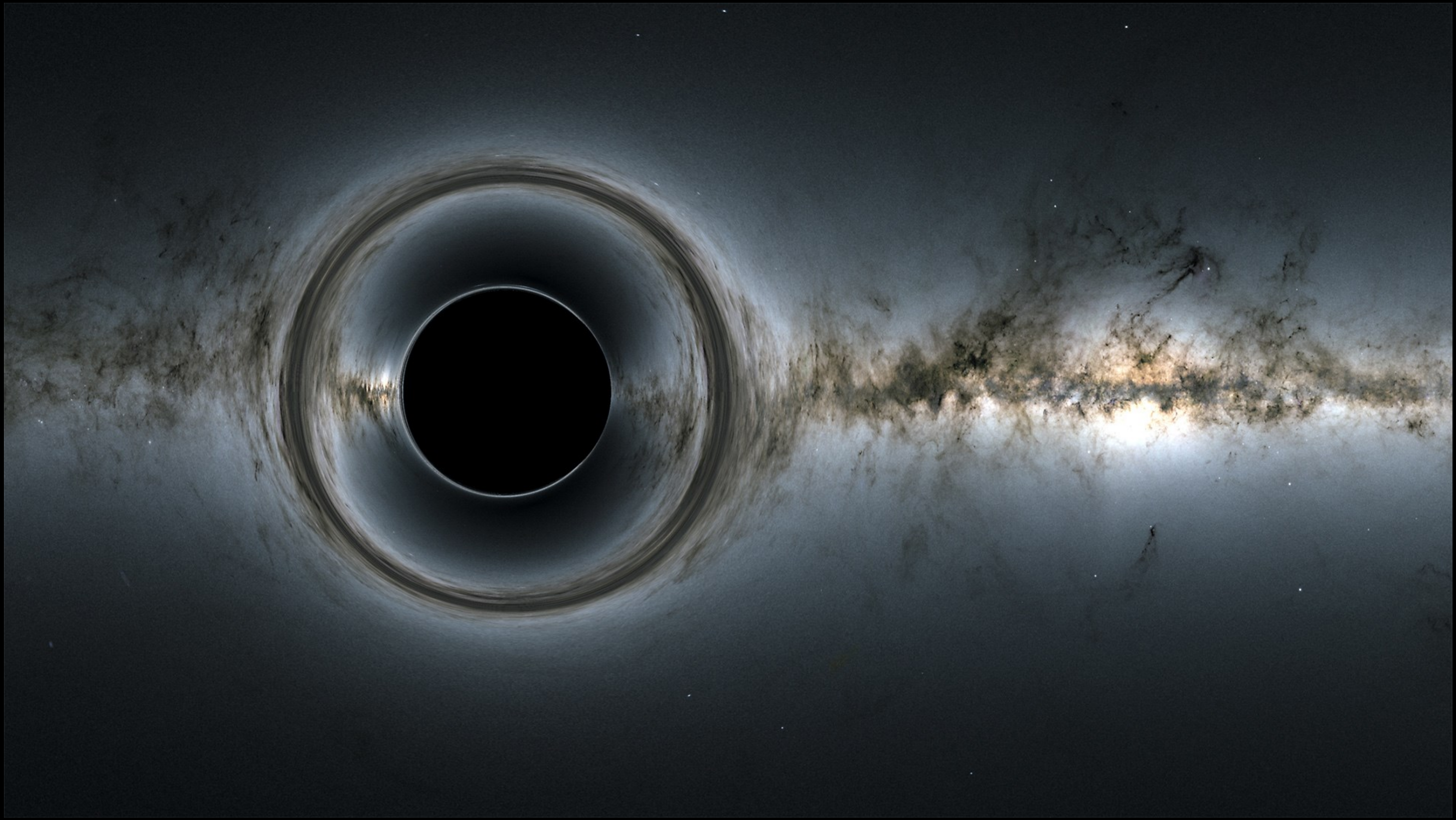
Temná hviezda ≠ Čierna diera

Nepriame vyžarovanie	Vnútorná štruktúra	Supermasívne

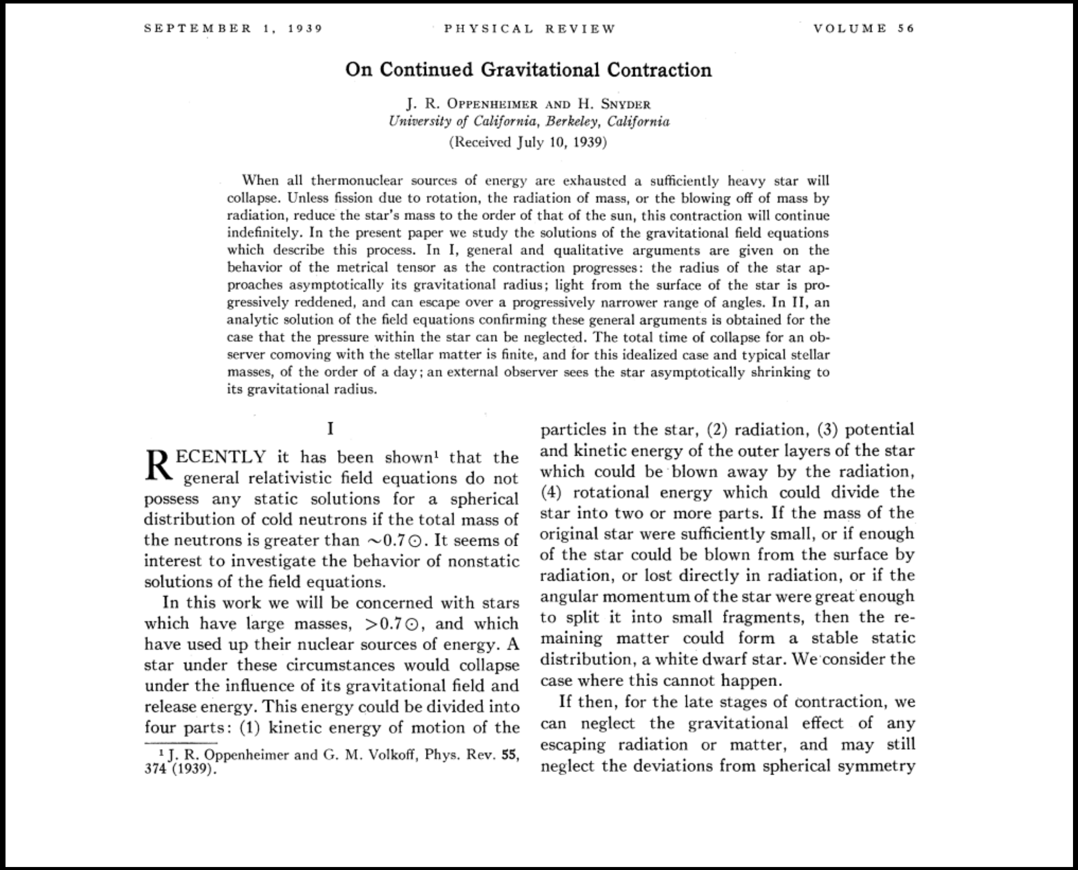




Máme čiernu dieru – ale ako?



Prvý článok ako získať čiernu dieru



SEPTEMBER 1, 1939 PHYSICAL REVIEW VOLUME 56

On Continued Gravitational Contraction

J. R. Oppenheimer and H. Snyder
University of California, Berkeley, California

(Received July 10, 1939)

When all thermonuclear sources of energy are exhausted a sufficiently heavy star will collapse. Unless fission due to rotation, the radiation of mass, or the blowing off of mass by radiation, reduce the star's mass to the order of that of the sun, this contraction will continue indefinitely. In the present paper we study the solutions of the gravitational field equations which describe this process. In I, general and qualitative arguments are given on the behavior of the metrical tensor as the contraction progresses: the radius of the star approaches asymptotically its gravitational radius; light from the surface of the star is progressively reddened, and can escape over a progressively narrower range of angles. In II, an analytic solution of the field equations confirming these general arguments is obtained for the case that the pressure within the star can be neglected. The total time of collapse for an observer comoving with the stellar matter is finite, and for this idealized case and typical stellar masses, of the order of a day; an external observer sees the star asymptotically shrinking to its gravitational radius.

I

RECENTLY it has been shown[1] that the general relativistic field equations do not possess any static solutions for a spherical distribution of cold neutrons if the total mass of the neutrons is greater than $\sim 0.7\odot$. It seems of interest to investigate the behavior of nonstatic solutions of the field equations.

In this work we will be concerned with stars which have large masses, $>0.7\odot$, and which have used up their nuclear sources of energy. A star under these circumstances would collapse under the influence of its gravitational field and release energy. This energy could be divided into four parts: (1) kinetic energy of motion of the particles in the star, (2) radiation, (3) potential and kinetic energy of the outer layers of the star which could be blown away by the radiation, (4) rotational energy which could divide the star into two or more parts. If the mass of the original star were sufficiently small, or if enough of the star could be blown from the surface by radiation, or lost directly in radiation, or if the angular momentum of the star were great enough to split it into small fragments, then the remaining matter could form a stable static distribution, a white dwarf star. We consider the case where this cannot happen.

If then, for the late stages of contraction, we can neglect the gravitational effect of any escaping radiation or matter, and may still neglect the deviations from spherical symmetry

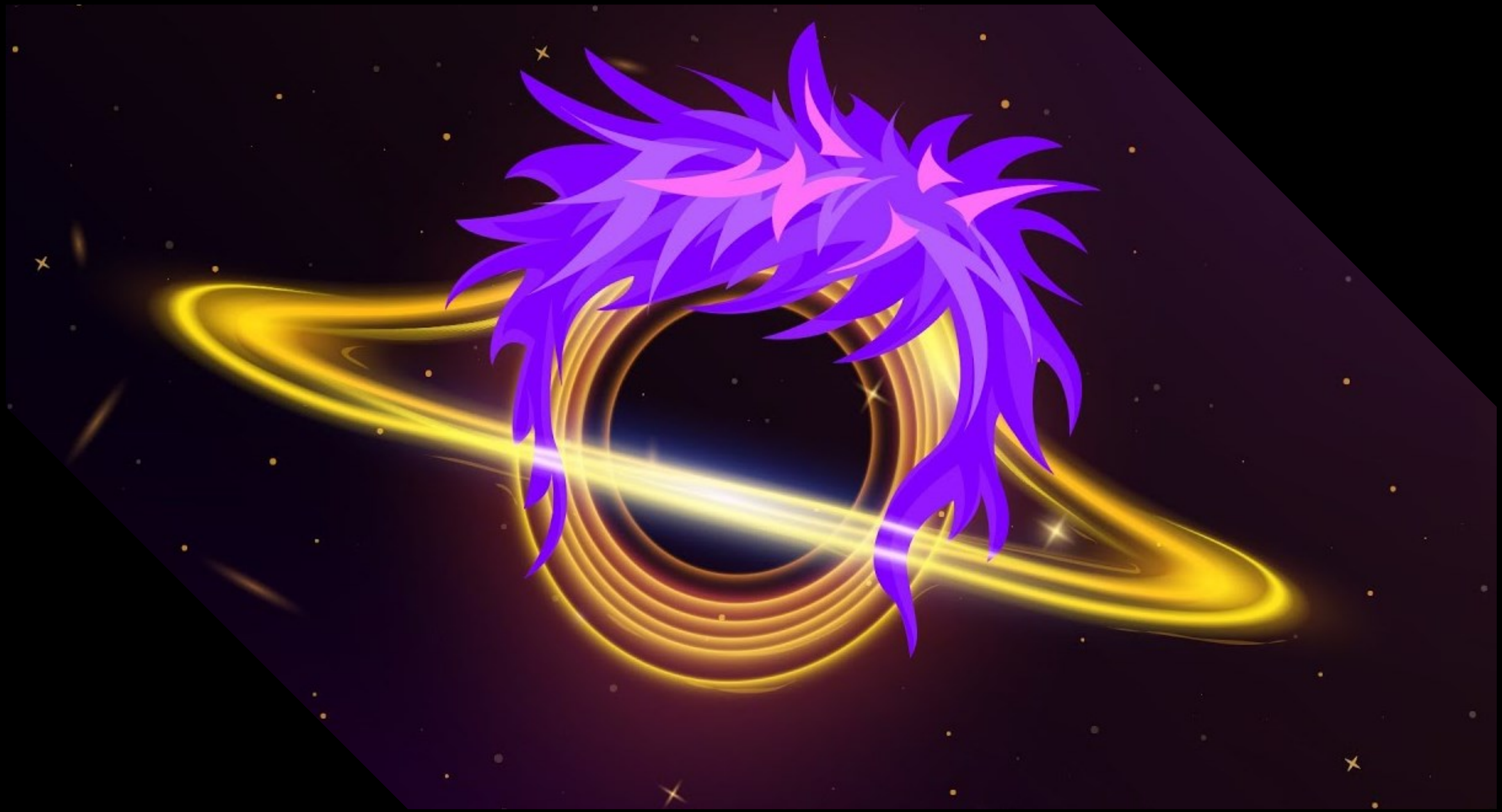
[1] J. R. Oppenheimer and G. M. Volkoff, Phys. Rev. 55, 374 (1939).

Julius Robert Oppenheimer

Prvý článok o vzniku čiernych dier

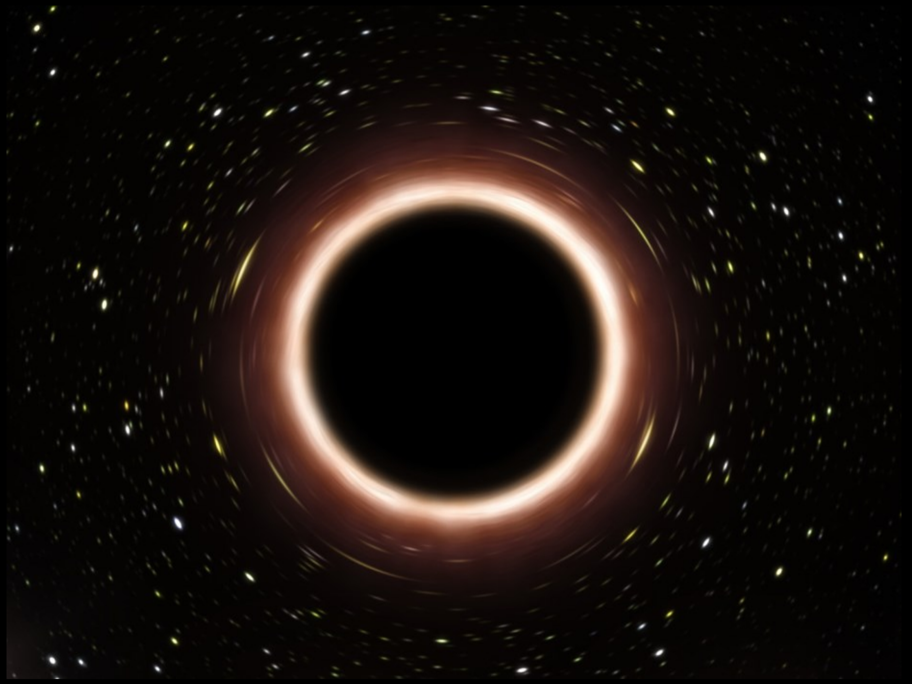
Základné vlastnosti a prejavy

Čierna diera nemá vlasy

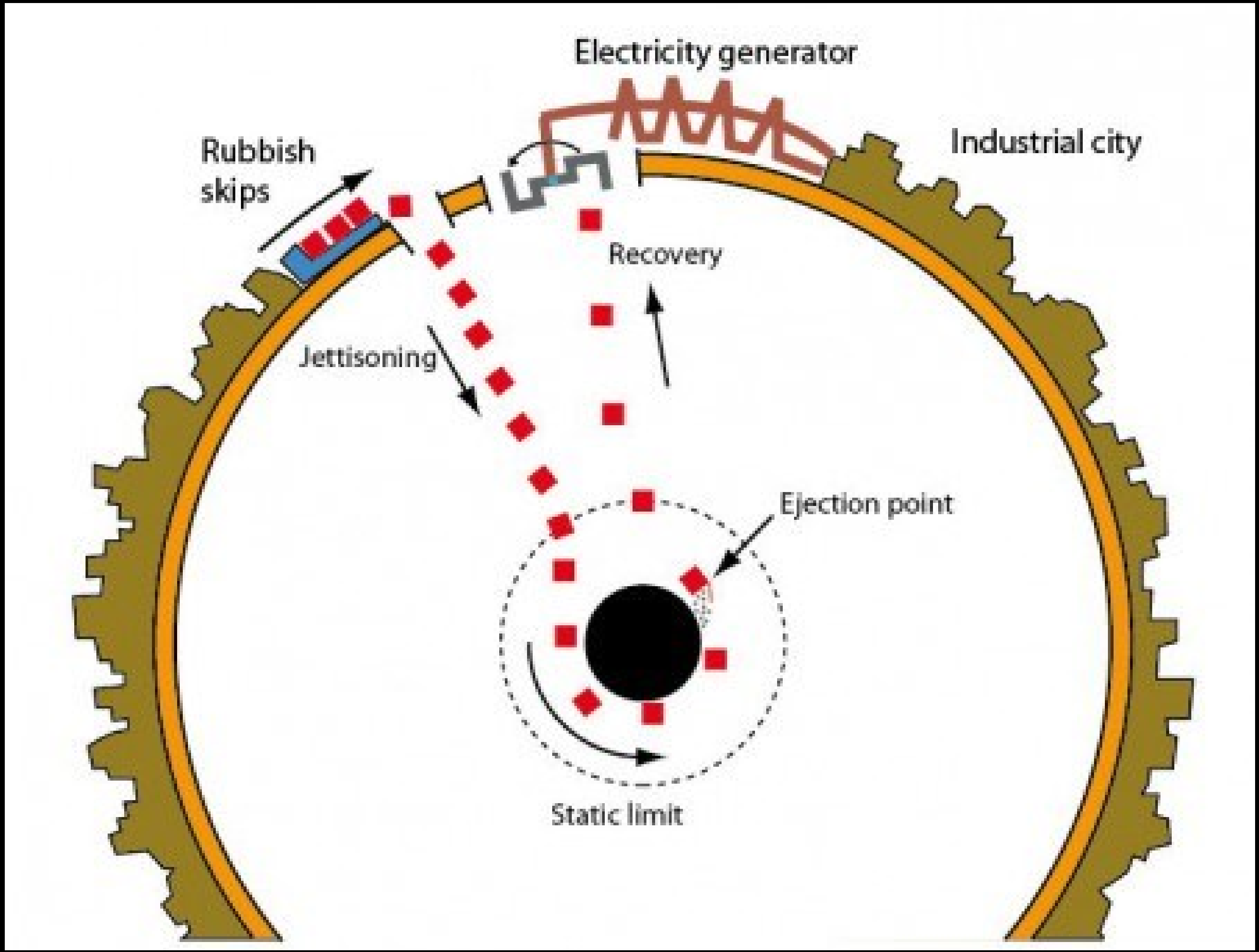


Delenie čiernych dier

Hviezdne	Stredné	Supermasívne
Pod 100 $M_{\odot}$	Medzi 100 a 10´000 $M_{\odot}$	Viac ako 10´000 $M_{\odot}$



Zdroj energie – Penrose mechanizmus

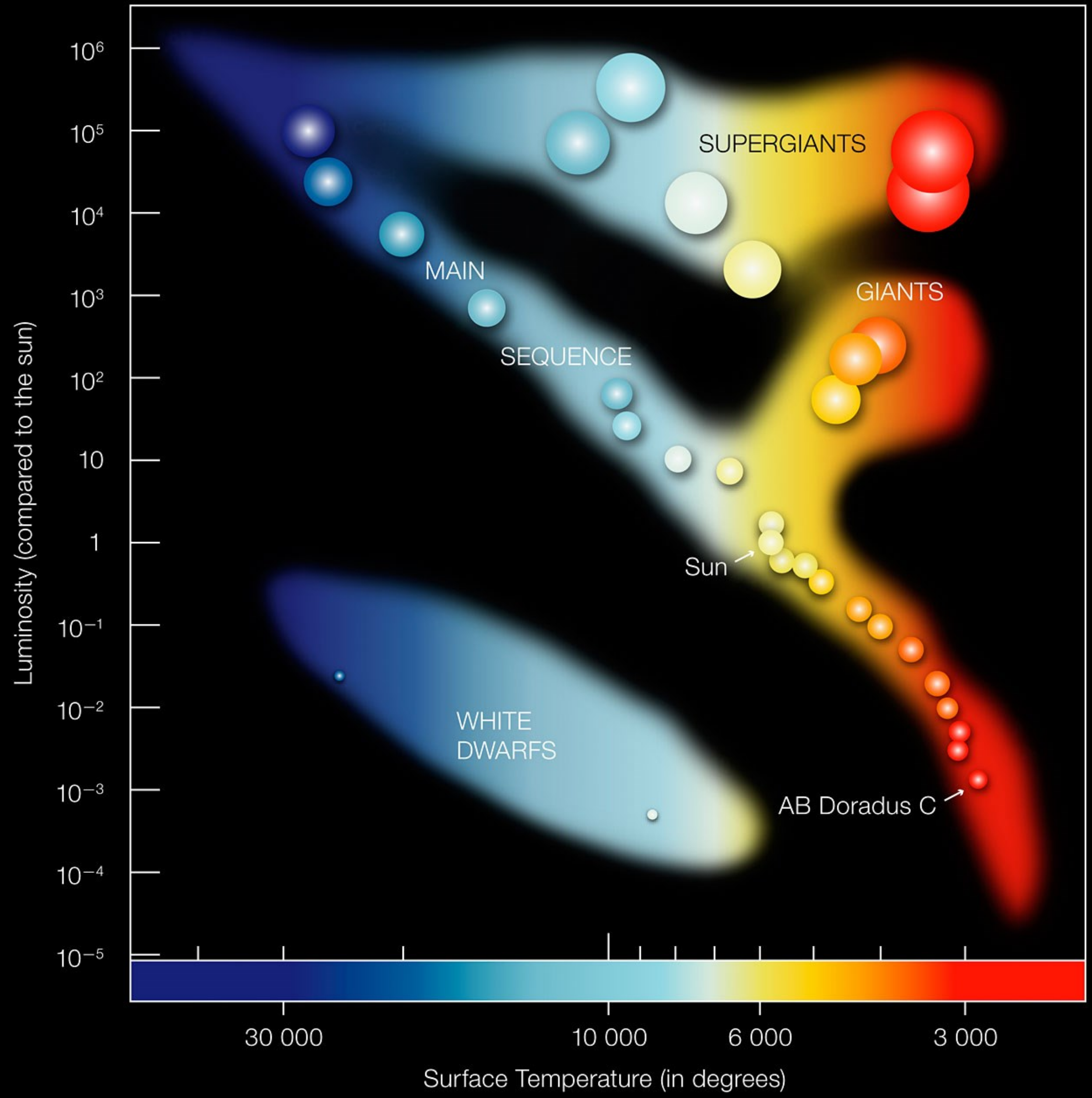


Exotické teórie

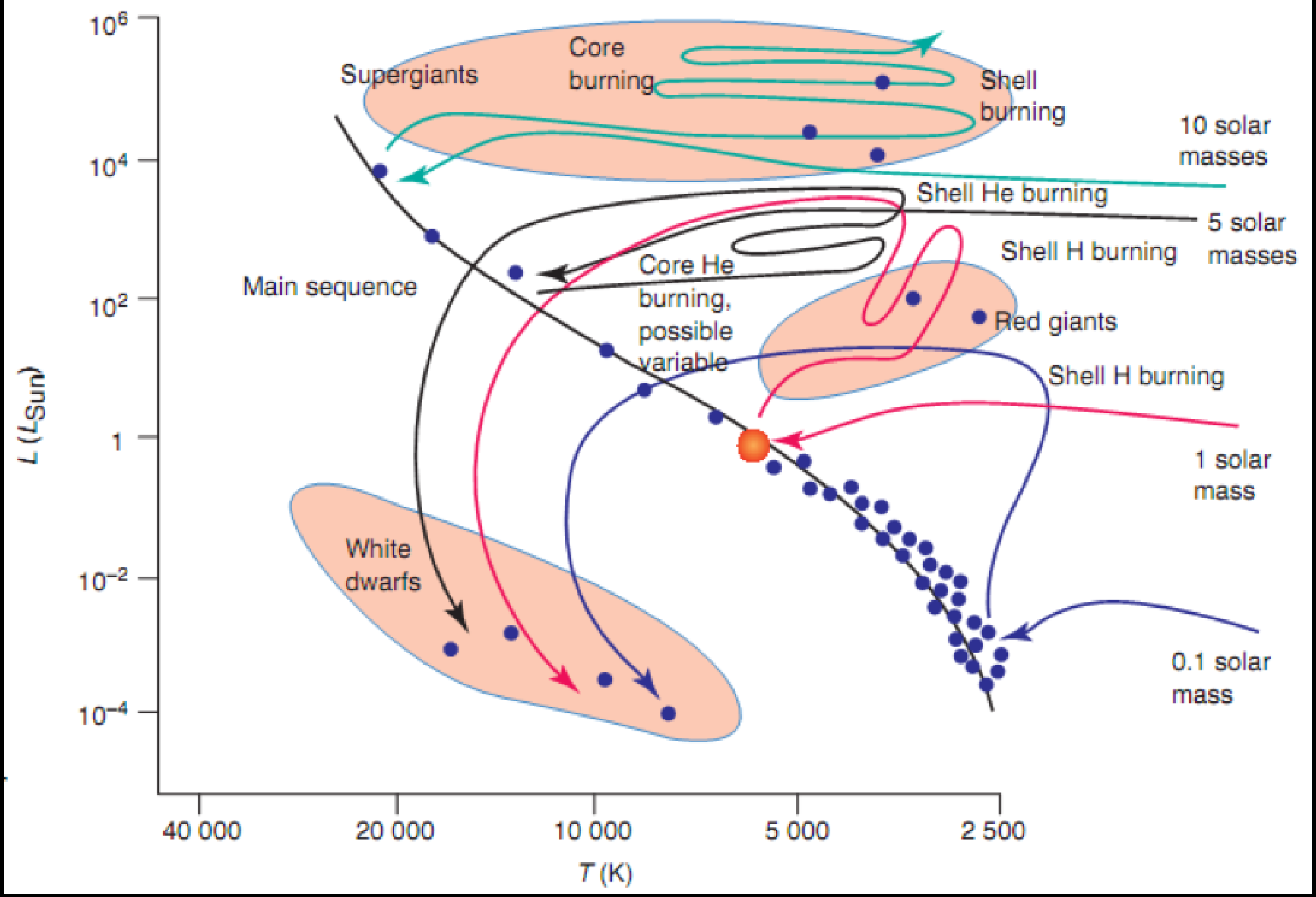
- Natiahnute singularity
- Nahe singularity
- Biele diery
- Červie diery

Vznik

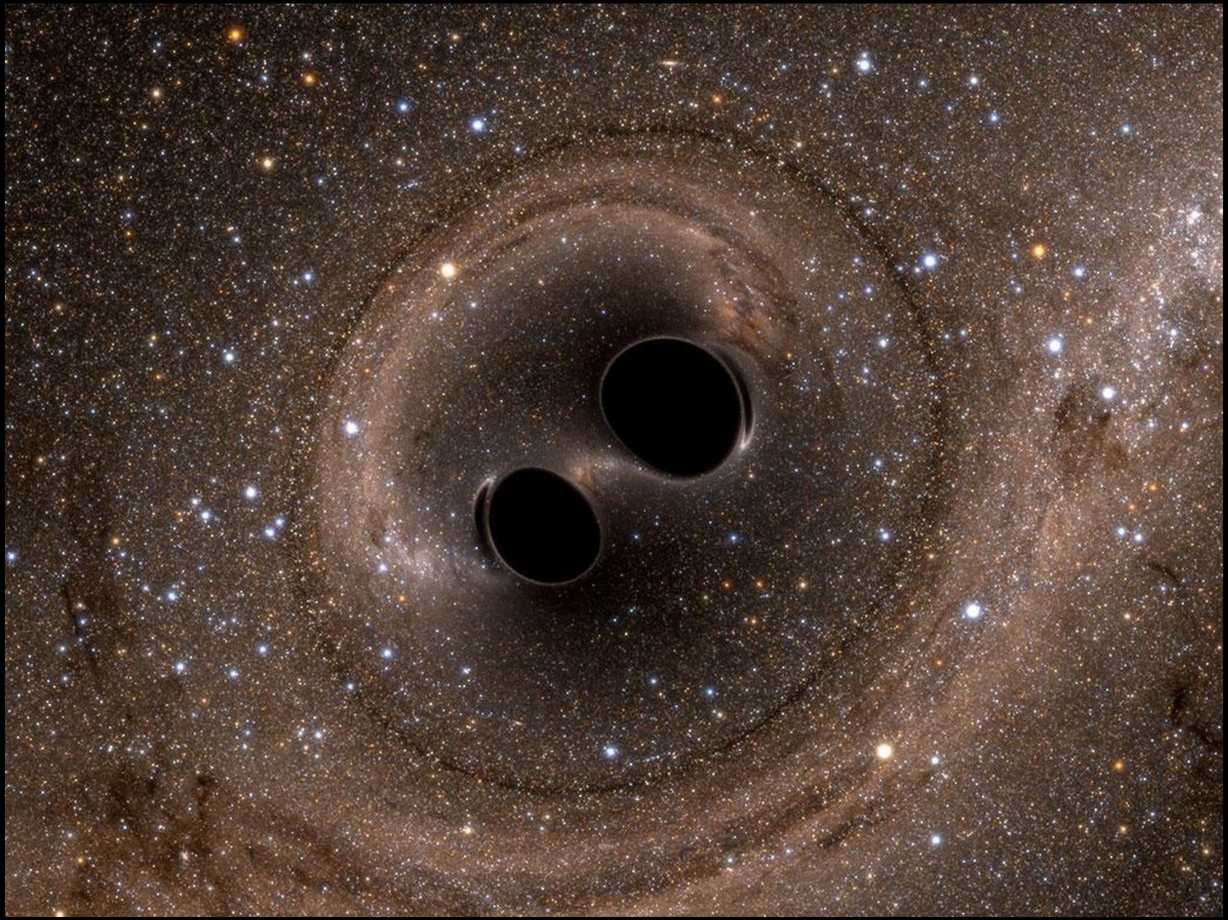
Hviezdne Čierne diery – kolaps hviezdy

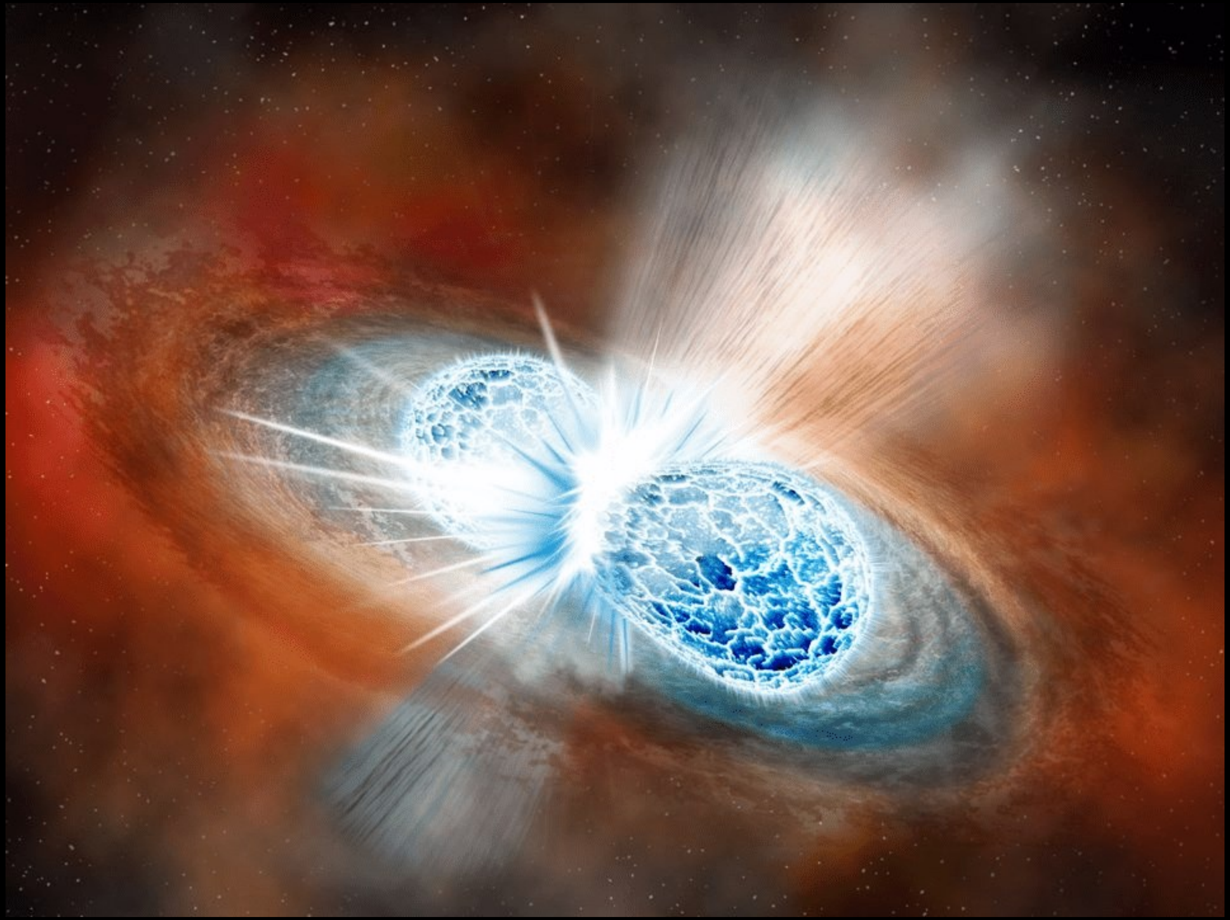


Hviezdne Čierne diery – kolaps hviezdy

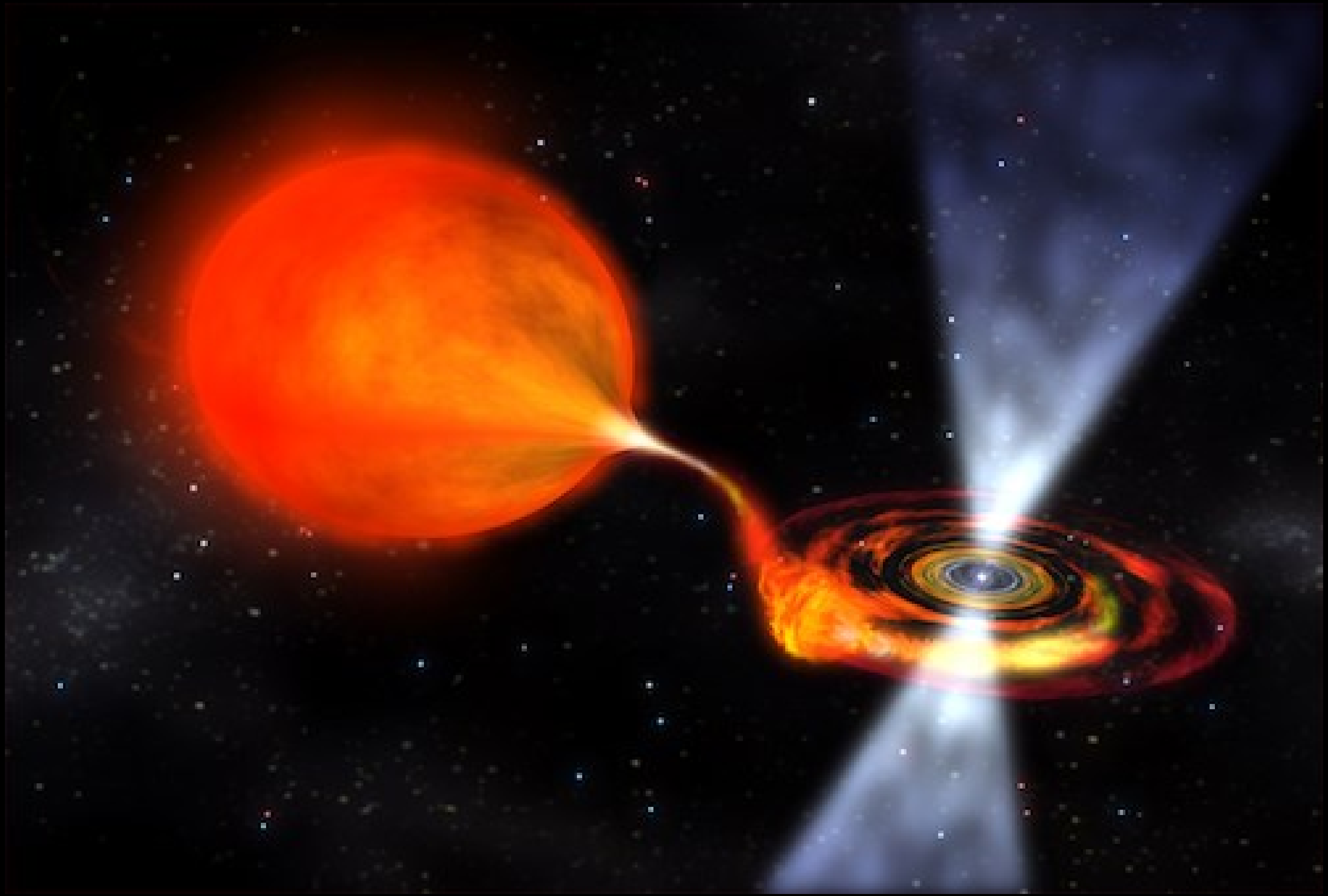


Zlučovanie čiernych dier (a iných…)

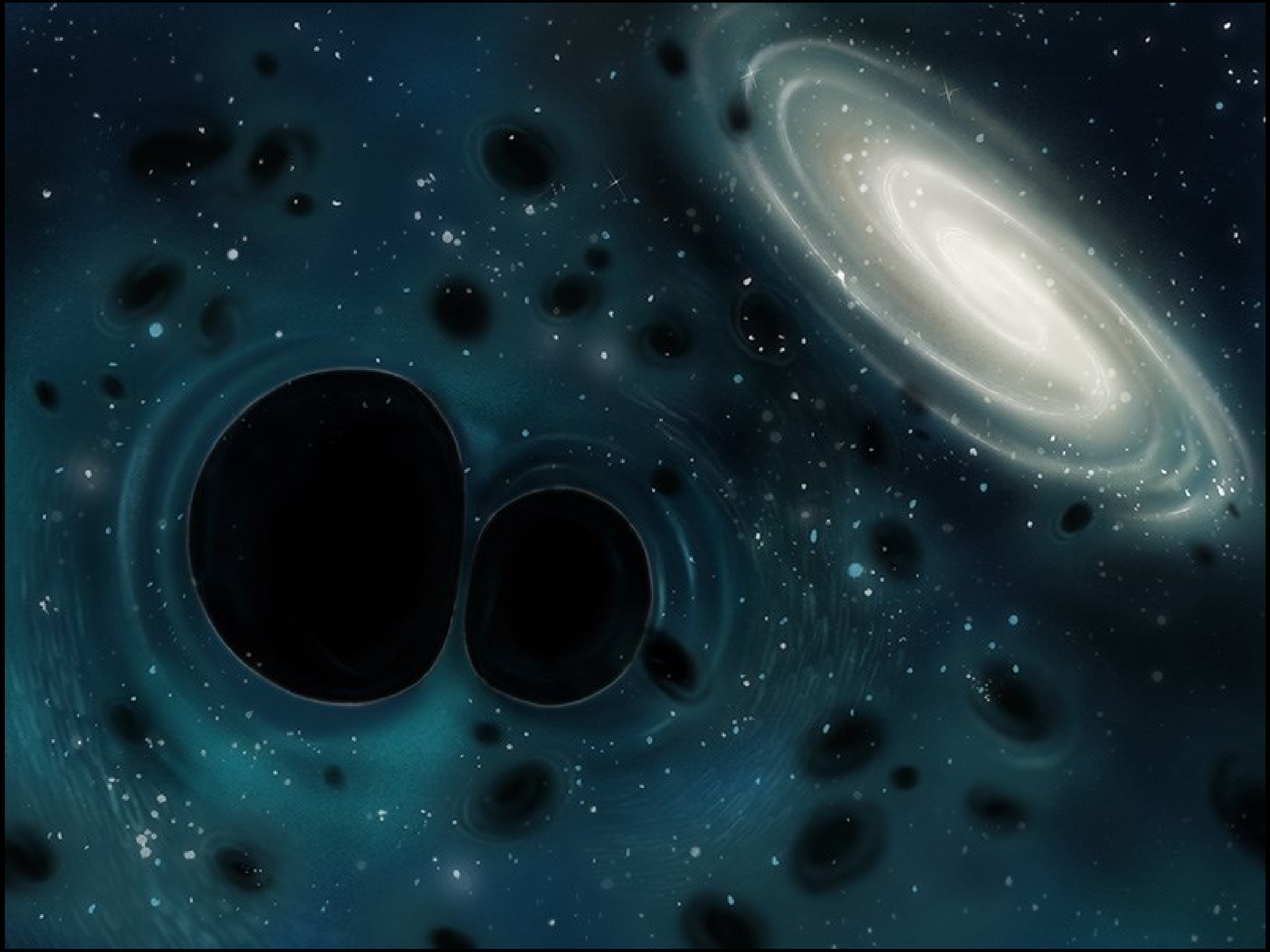




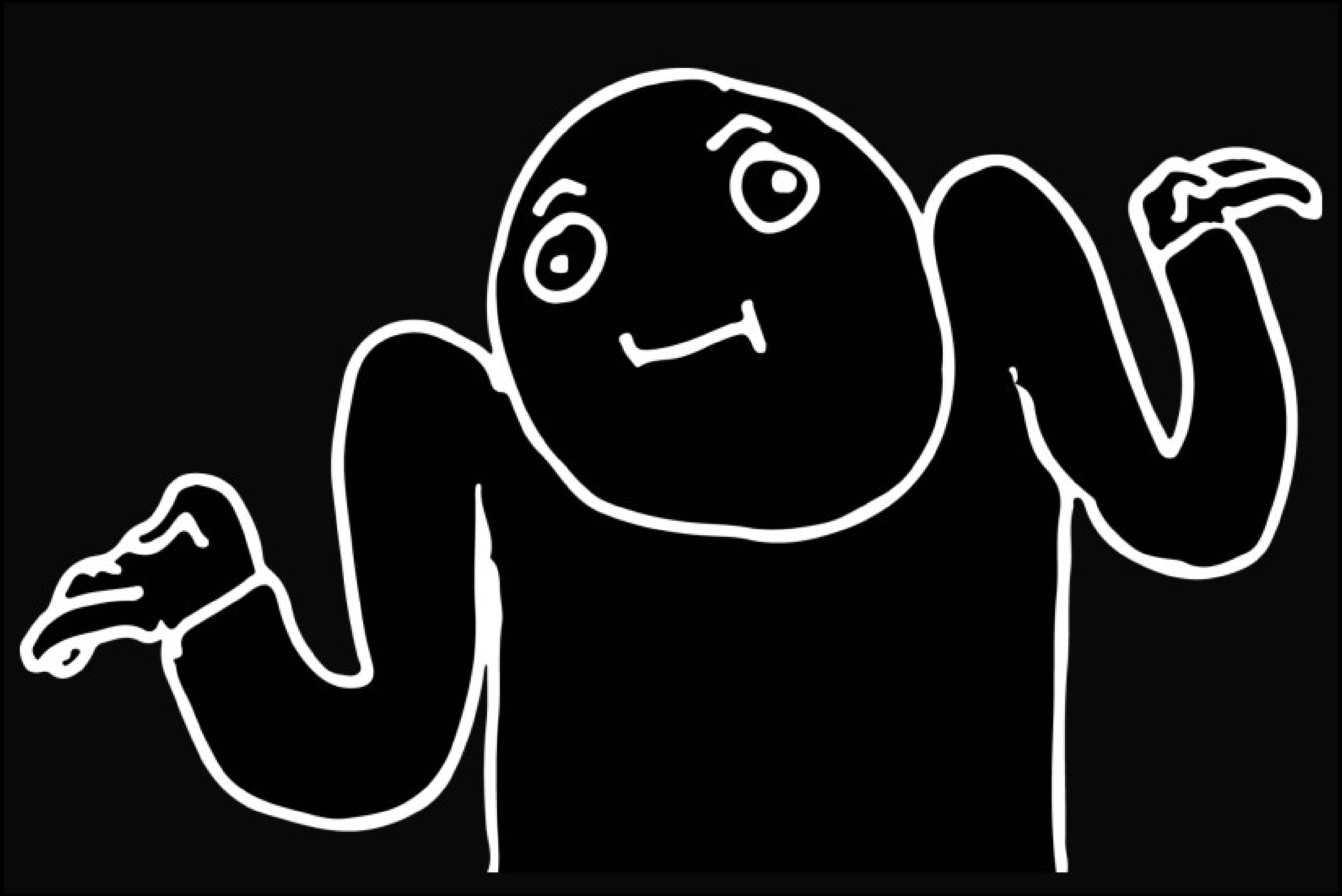
Nabaľovanie hmoty



Primordiálne čierne diery

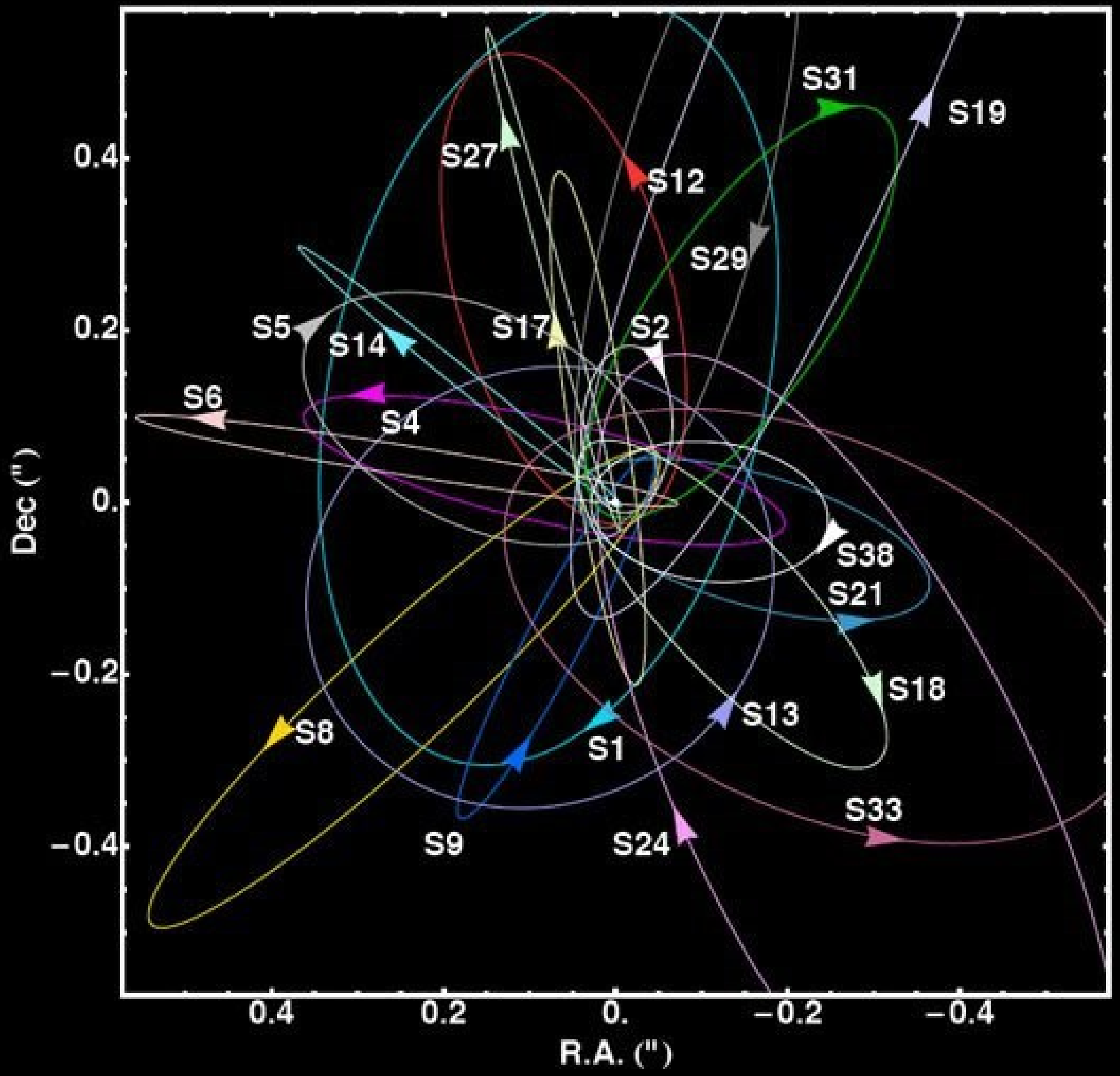


Vznik supermasívnych čiernych dier

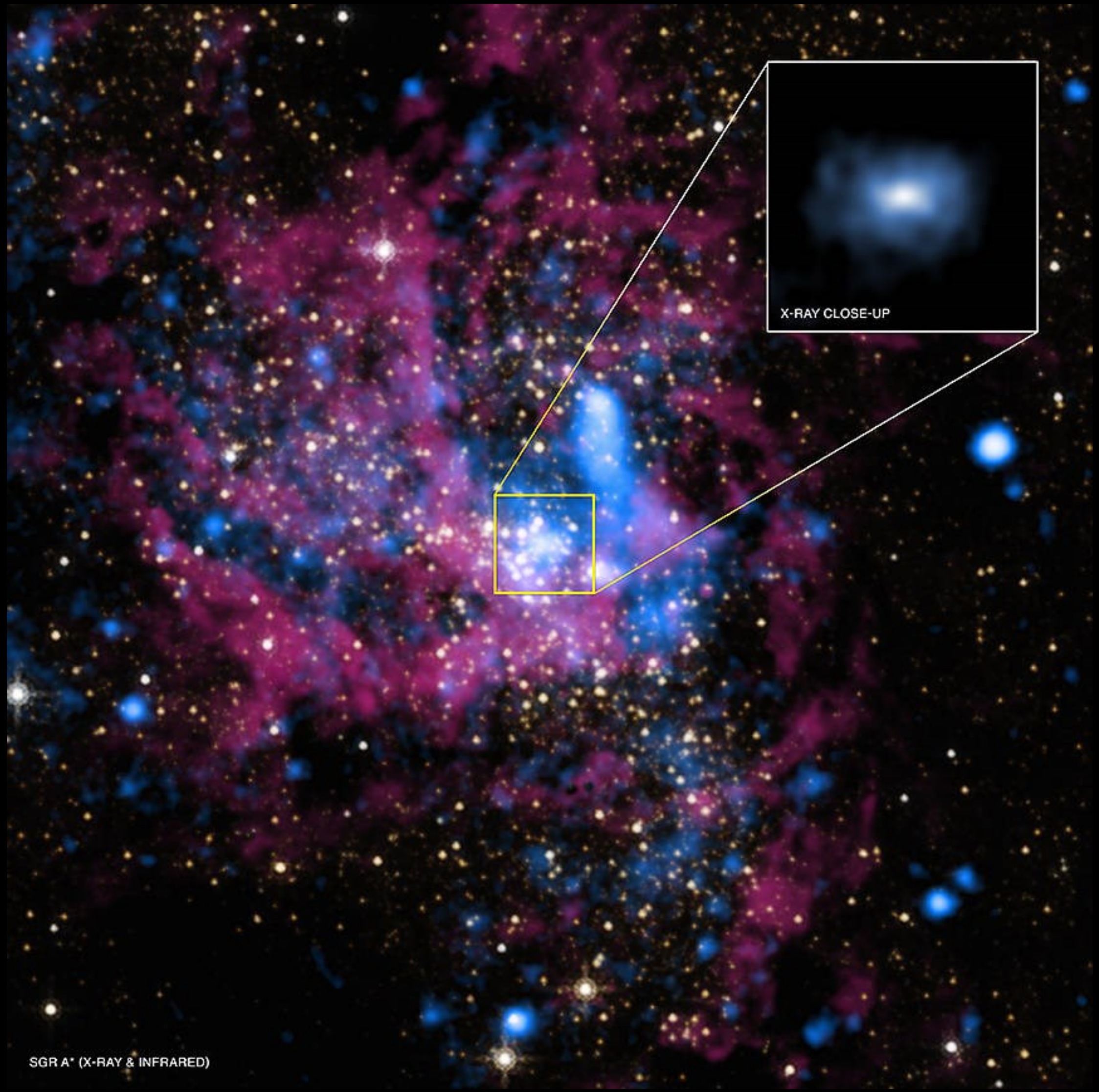


Pozorovanie

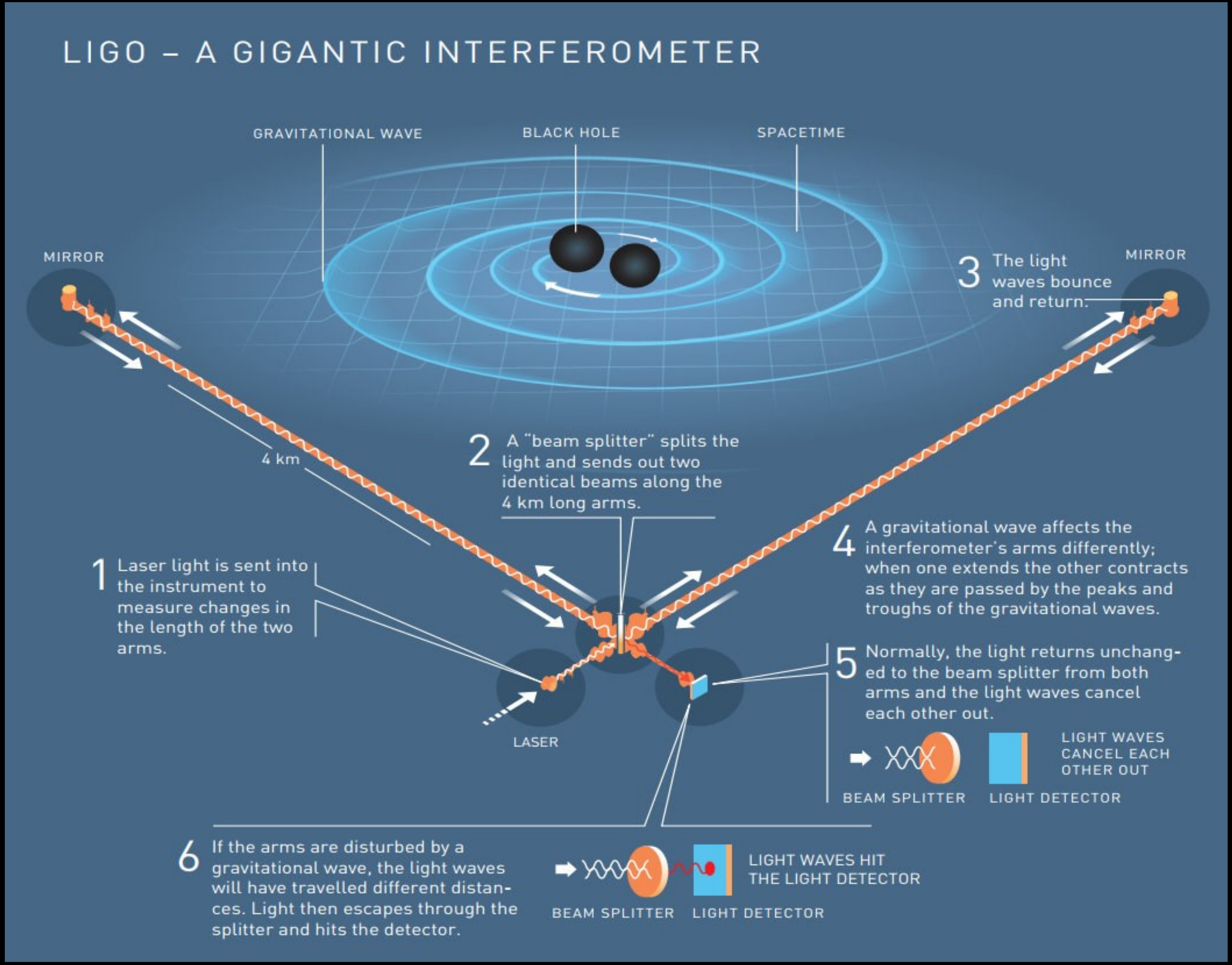
Gravitácia – Nie vlny



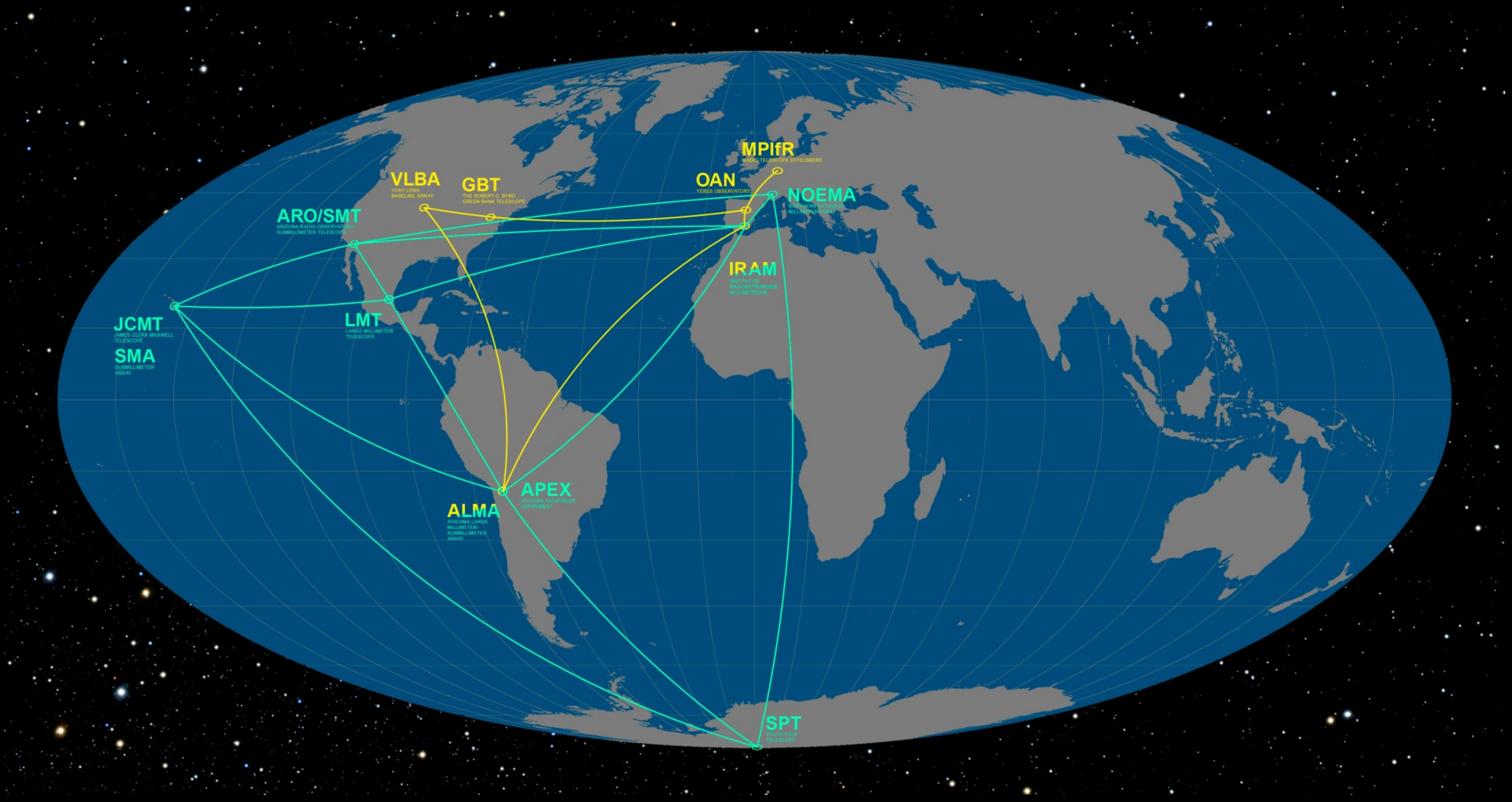
Rádio, Röntgen a iné žiarenia



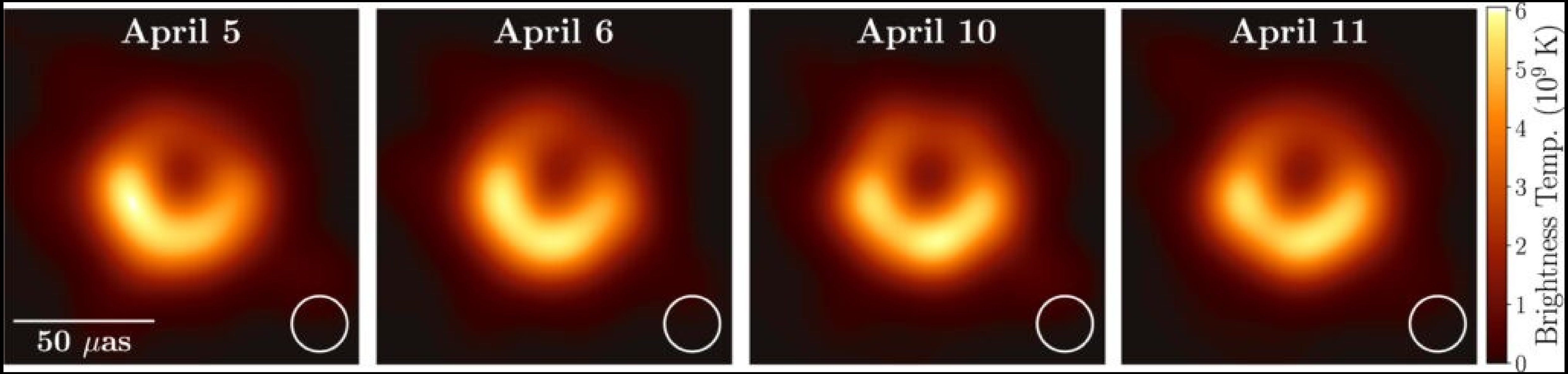
Gravitácia – Už ale vlny



„Fotografia“

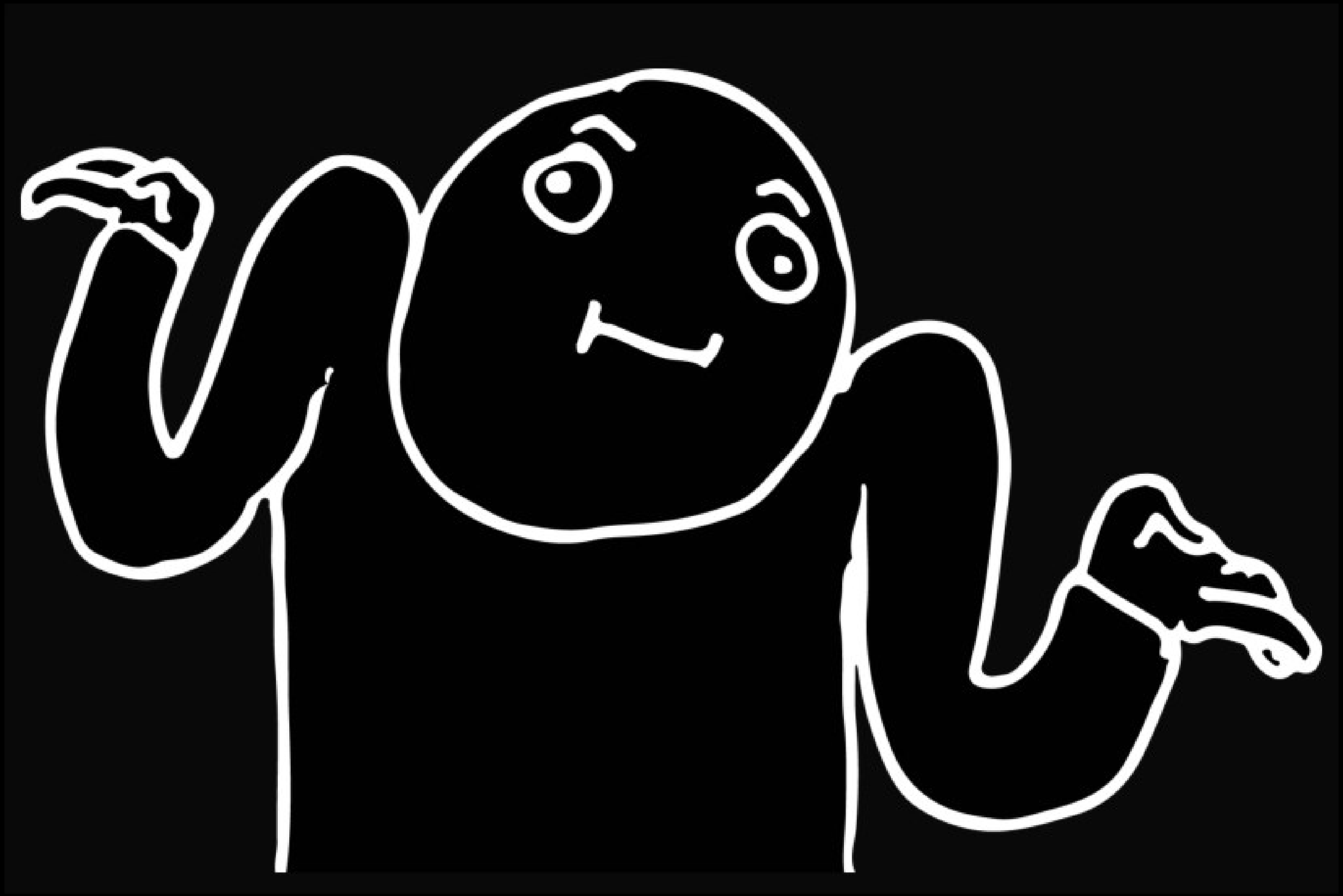

MPIfR
RADIO TELESCOPE EFFELSBERG
VLBA
VERY LONG
BASELINE ARRAY
GBT
THE ROBERT C. BYRD
GREEN BANK TELESCOPE
OAN
YEBES OBSERVATORY
NOEMA
NORTHERN EXTENDED
MILLIMETER ARRAY
ARO/SMT
ARIZONA RADIO OBSERVATORY/
SUBMILLIMETER TELESCOPE
IRAM
INSTITUT DE
RADIOASTRONOMIE
MILLIMETRIQUE
JCMT
JAMES CLERK MAXWELL
TELESCOPE
SMA
SUBMILLIMETER
ARRAY
LMT
LARGE MILLIMETER
TELESCOPE
APEX
ATACAMA PATHFINDER
EXPERIMENT
ALMA
ATACAMA LARGE
MILLIMETER/
SUBMILLIMETER
ARRAY
SPT
SOUTH POLE
TELESCOPE

„Fotografia“

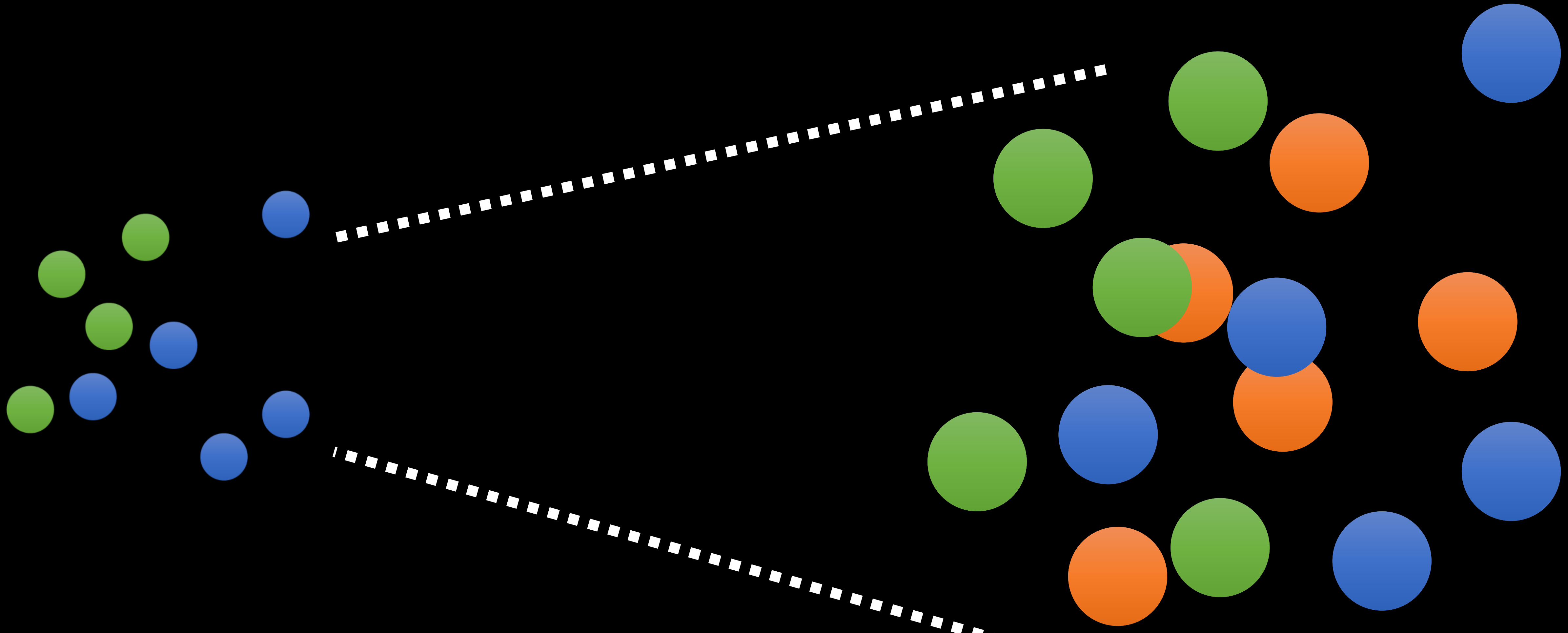

April 5
April 6
April 10
April 11
50 μas
Brightness Temp. (10^9 K)
6
5
4
3
2
1
0

Moderné problémy

Kde sú stredné čierne diery???

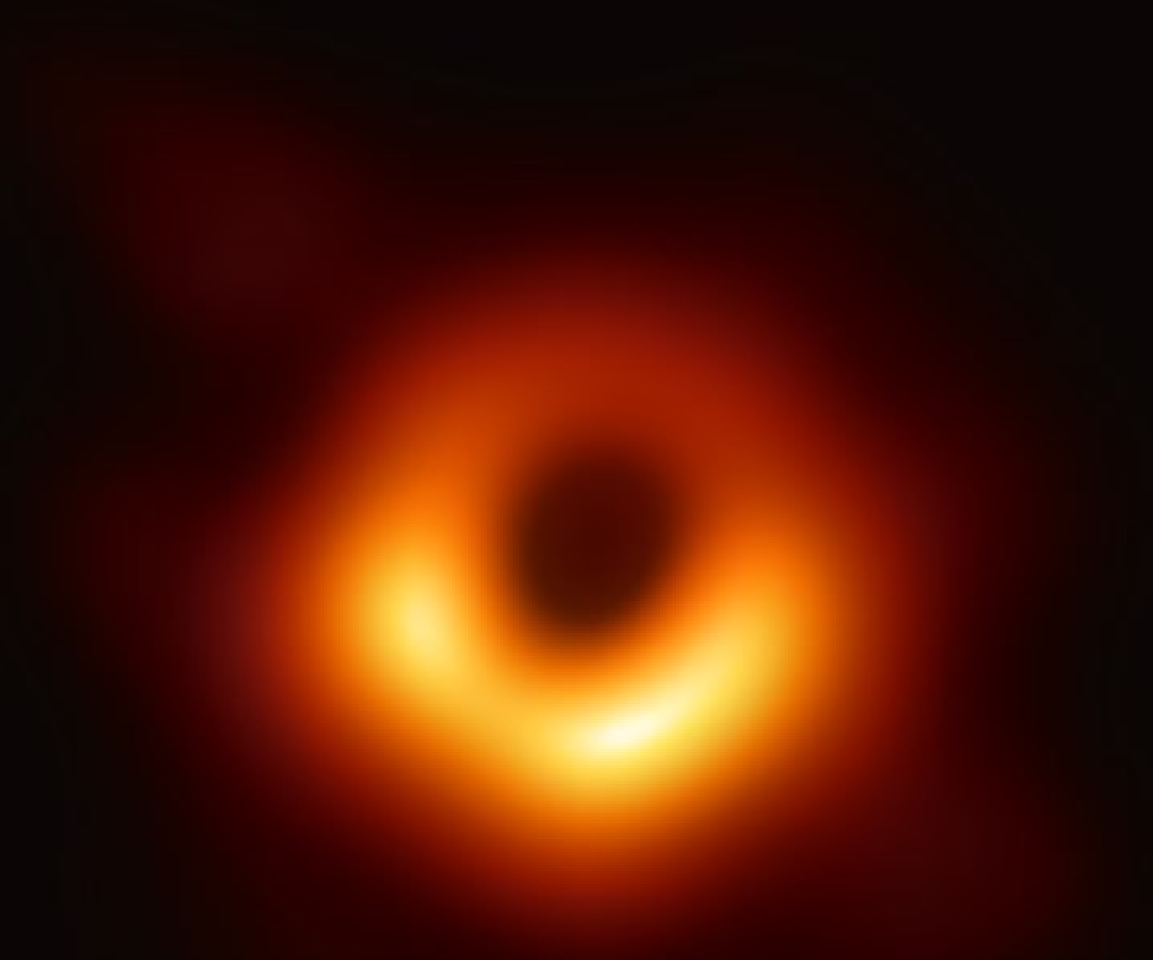


Stredné čierne diery – výberový bias



Stredné čierne diery – Práca pre vás

- Čo je hlavný problém?
- Čo hovoria pozorovania?
- Súčasné modely prečo nepozorujeme IMBH?
- Súčasné modely ako by mohli IMBH vznikať a zanikať?
- Čo by pomohlo k rozlúsknutiu tejto otázky?



Ďakujem za pozornosť

Samuel Amrich

Apendix