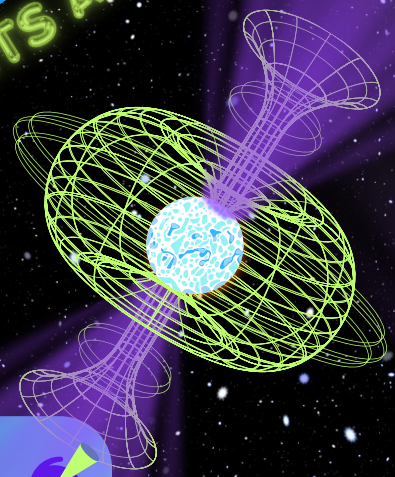
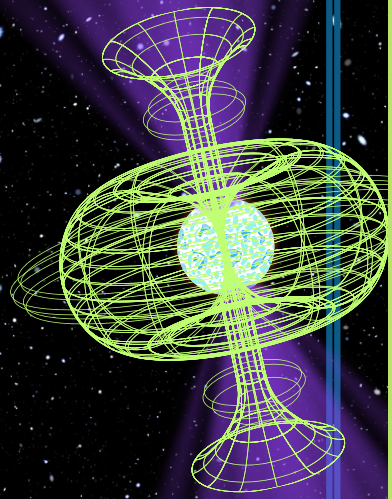
TRAPUM

TRANSIENTS AND PULSARS WITH MEERKAT





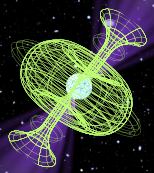
WHAT ARE PULSARS?

EXPLORING THE MEERKAT TELESCOPE

FREE PRINTABLE PULSAR ILLUSION INSIDE!

ASTROPHYSICISTS AROUND THE WORLD!

LOTS OF AMAZING STUFF IS WAITING FOR YOU



WHAT'S INSIDE?

TRAPUM is the short form for the scientific project with the long name "Transients and Pulsars with MeerKAT". Scientists love abbreviations and therefore always give their projects a long name, which they can then abbreviate. In TRAPUM, the scientists have taken the Tra from Transients, the Pu from Pulsars and the M from MeerKAT and strung them together.

The long name of the project consists of words you may never have heard before. But that's no problem at all, because we will explain all these words to you on the next pages of this booklet. Here's a little teaser: transients are very special events, pulsars have something to do with stars, and MeerKAT is a radio telescope in South Africa.

Hello there! Welcome to the amazing world of radio astronomy.
I would be happy to join you as you read, learn and wonder. Who am I, you ask? I'm a meerkat and I live in southern Africa. That's where the MeerKAT telescope, which was named after me, is located. Of course I'm very proud of that. However, I don't have my own name yet. Would you like to give me one? Please write it here:

You'll spot me from time to time in this magazine. Can you find out how often?

And there's another strange word: radio telescope. Scientists use radio telescopes to do radio astronomy. You may have heard that an astronomer uses a telescope to look at the night sky. Thanks to the telescope, an astronomer can observe distant stars, planets, moons and much more, really well.

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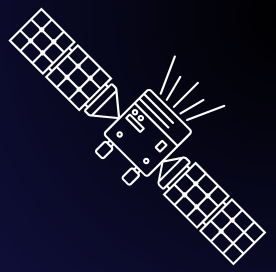
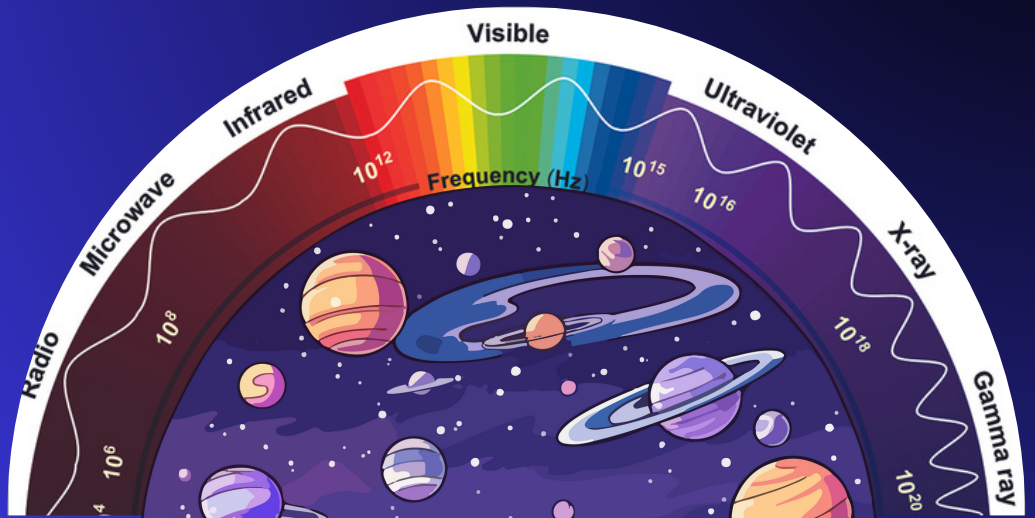
THE ELECTROMAGNETIC SPECTRUM

But how can you observe with a radio telescope? Everything around us emits electromagnetic waves that can have very different wavelengths. With our eyes, we can see only a very small part of this entire electromagnetic spectrum - visible light. If the wavelengths become longer than those of visible light, we enter the infrared range. In the smaller wavelength range, the ultraviolet is next to the visible light. As you can see in the figure, radio waves have much longer wavelengths than visible light and are hidden from our eyes. However, we can make them "visible" with a radio telescope.





So, in radio astronomy, we use a radio telescope to collect the radio waves emitted by astronomical objects, decode them with a receiver system including computer, and thus be able to observe it. In this way, radio astronomers can make visible objects that we could not see in the wavelength range of visible light - such as the black hole at the center of our Milky Way.

The radio telescope in Effelsberg (Germany) has a diameter of 100 meters. If 31 elephants stand in a row, this row is also 100 meters long. The telescope weighs 3200 tons. That's as much as 800 elephants.

The telescope on the right is called FAST and is located in China. It has a diameter of 520 meters. That's about five times more than the long side of a soccer pitch. FAST is the world's largest radio telescope.

The Very Large Array (VLA) is located in the USA and consists of 28 antennas. If you use all the antennas together, it's like having a telescope with a diameter of 36 kilometers.

THE WONDERFUL WORLD OF TRANSIENTS AND PULSARS

WHAT ARE TRANSIENTS?

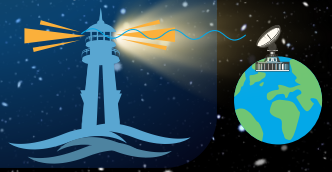
Transients occur only once and last only for a very short time. This can be, for example, a fast radio burst: a phenomenon in extremely distant parts of the universe that does not even last as long as the blink of an eye. In this short time, radio waves are produced that can be registered with telescopes such as MeerKAT.

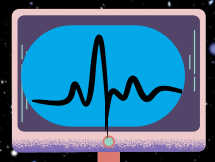
PULSARS

Just like humans, stars have a life - they are born and they die. Some stars explode at the end of their life in a supernova and new stars are born. A very special star with a lot of mass in a small space is a neutron star (Look also at the explanation about neutron stars!). If this neutron star rotates uninterruptedly very fast around its own axis and emits electromagnetic radiation from its poles it is called a pulsar.

We can compare pulsars to lighthouses. However, this special "lighthouse" does not emit visible light but mainly radio waves. While the pulsar rotates very fast around its own axis, this radio beam becomes "visible" for us on Earth for a short time and then disappears again until it reappears.

Of course we cannot see the radio beam with our eyes but need radio telescopes like MeerKAT.





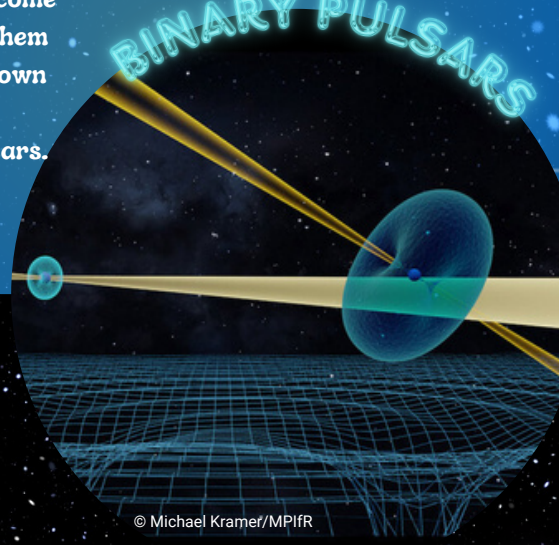
NEUTRON STARS

Neutron stars are extremely heavy stars but are also small. A neutron star is about 12 kilometers in diameter. This is 500 times smaller than the Earth but weighs 500,000 times more than the earth

A neutron star has a very thin atmosphere. Underneath lies the outer crust, which is gaseous. The following inner crust consists of a warm liquid and encloses the core of the neutron star. Also at the core the outer and the inner part are distinguished. The outer core is gaseous again, while the inner core contains a plasma. The density increases from the outside to the inside. That means that the matter, of which the neutron star consists, is squeezed inside more than outside.

In a binary system, two astronomical objects orbit around a shared center. These astronomical objects can be for example stars, planets and moons or galaxies. But there are also binary systems with neutron stars. Neutron stars in binary systems transfer matter. This is called accretion. Because the neutron stars receive matter, they get more mass, so they become heavier. The transfer of matter make them rotate faster and faster around their own axis. They can become so fast that astronomers call them millisecond pulsars. Using double systems of pulsars, astronomers can even test Einstein's theory of general relativity.

BINARY PULSARS



© Michael Kramer/MPIfR

THE MAJESTIC MEERKAT TELESCOPE

Photo credits: SARAO

The radio telescope used by scientists in the TRAPUM project is located in the Karoo Desert in South Africa and consists of many dish-shaped individual antennas. These individual antennas can be networked together and then look or listen into the universe together as a large telescope.

The name MeerKAT is also an abbreviation. The original name was KAT, which is short for "Karoo Array Telescope." When the telescope was given that name, it consisted of 7 individual dish-shaped antennas. Subsequently, many more antennas were built, so that the telescope now consists of 64 individual antennas. Therefore, the telescope got a new name, which means "more of KAT": MeerKAT. You may have heard the word meerkat in another context. Meerkat is also the name of a small mammal that lives in the Karoo Desert in South Africa. So, the name fits perfectly.

HIDE AND SEEK: PULSAR EDITION

Photo credits: Spitzer, WISE, MeerKAT /Judy Schmidt
European Southern Observatory (ESO)

To find and study nearby pulsars, astronomers go searching in our Milky Way galaxy. TRAPUM looks for pulsars in globular clusters, the Large and Small Magellanic clouds and the galactic plane. This is a MeerKAT image of the Milky Way galaxy from Earth.

Astronomers also find pulsars in the galactic plane. The Milky Way is a bit like a frisbee, and when seen from Earth, it looks like a thin region we call the galactic plane. Pulsars are found here in many gas and dust clouds where new stars are formed.

At the center of our galaxy - the Milky Way - there is a supermassive black hole. It is called Sagittarius A* (Sgr A*) and has an extremely strong gravitational pull. Everything that is near the black hole is gravitated towards it. And once it has been "eaten" by the black hole, it can't get out again. Could there be a pulsar orbiting this massive black hole? If so, that could help us test Einstein's theory of general relativity

Maybe a pulsar is hiding in one of the globular clusters?
A globular cluster contains numerous stars which gravitationally attract each other. There are many globular clusters in the Milky Way and many pulsars have been discovered in them.

The Small and Large Magellanic Clouds are also good spots for pulsars
The Small Magellanic Cloud (SMC) and the Large Magellanic Cloud (LMC) are two dwarf galaxies near our Milky Way. They can only be observed in the southern sky.

GAME CENTRAL STATION

Let's ~~Rock it~~ Rocket!

Gotta TRAPUM all!

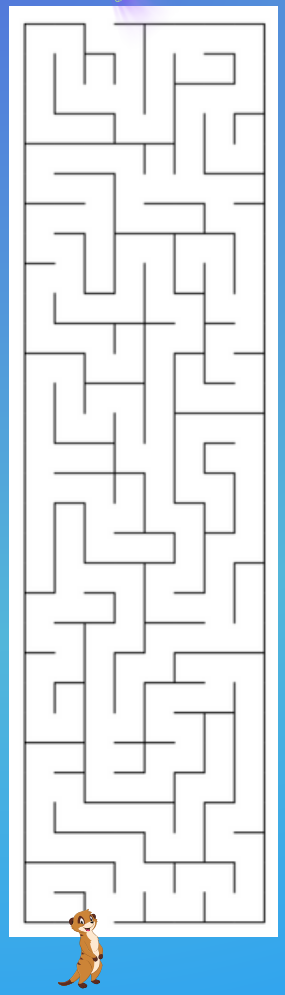
R	E	S	M	R	D	N	S	G	I	A	E	I	A
L	P	L	C	G	S	O	R	A	S	L	U	P	C
S	O	A	M	M	U	N	L	L	R	D	L	I	S
D	C	V	C	C	N	E	A	A	A	N	O	S	C
N	S	O	R	R	D	X	M	C	T	X	B	G	I
O	E	N	S	M	S	O	A	T	S	O	I	D	S
C	L	R	N	N	I	P	G	I	N	C	G	N	Y
E	E	E	B	E	D	L	N	C	O	M	R	R	H
S	T	P	I	O	M	A	E	P	R	S	A	O	P
I	O	U	N	O	C	N	T	L	T	T	V	O	O
L	I	S	A	X	S	E	A	A	U	N	I	R	R
L	D	N	R	N	N	T	R	N	E	I	T	L	T
I	A	D	Y	T	I	P	L	E	N	N	Y	P	S
M	R	I	D	S	T	M	E	E	R	K	A	T	A

Can you spot these 15 words in the box above?

LMC
GALACTIC PLANE
DNS
MAGNETAR
RADIO TELESCOPE
BINARY
NEUTRON STAR
EXOPLANET
PULSAR
ASTROPHYSICS
MILLISECOND
SMC
SUPERNOVA
MEERKAT
GRAVITY

They can be hidden in any direction: from top to bottom, from bottom to top, from left to right, from right to left and even diagonally.

Sirius, the dog star, is moving closer to Earth at a rate of nine miles per second. This means someday we could be in Sirius trouble.

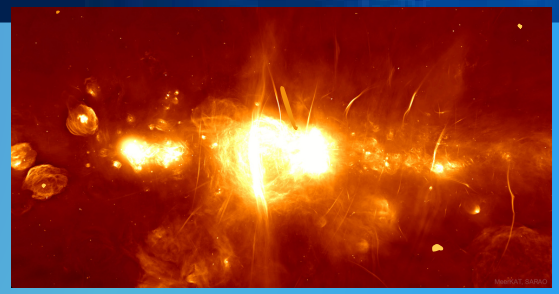


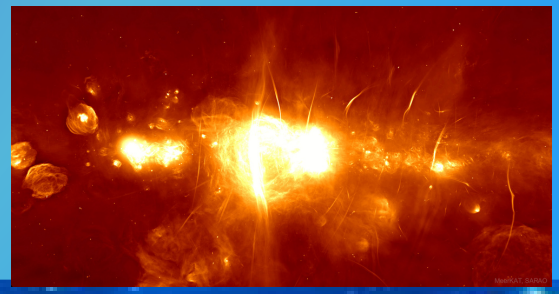
The little meerkat needs your help to reach the pulsar. Find the right way through the maze.

SPOT THE DIFFERENCE

At first glance, both images of the centre of the Milky Way with its black hole look the same. But we have put in five differences.
Can you spot them?

A quick hint from the meerkat: You can find the solution to the three puzzles on the last page.

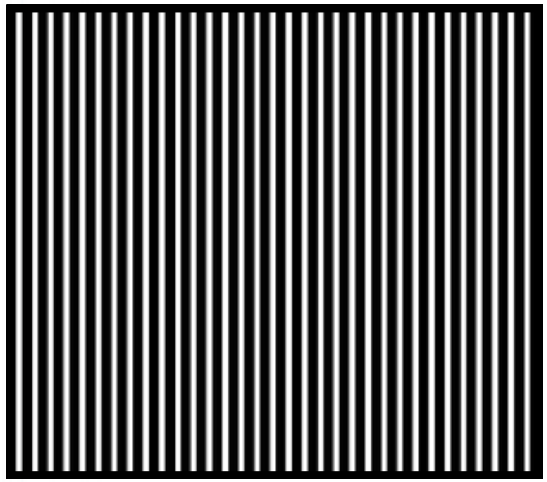




PRINTABLE!

Would you like to make your own pulsar rotate?

First, print out this page in at least A4 format. Then cut out the grid on the right-hand side. Then carefully cut away the white parts of the grid. Perhaps an adult can also help you here. Now all you have to do is slowly slide the grid over the pulsar image on the left-hand side. It actually looks as if the pulsar is spinning!



Bet you didn't know!
6 Facts about pulsars

A pulsar forms when an old star explodes in a supernova.

The first pulsar was discovered by chance in 1967 by the English student Jocelyn Bell.

Pulsars can spin up to 716 times per second. This is 1,5 times faster than a regular kitchen blender.

1 teaspoon of pulsar material would weigh as much as mount Everetst!

To escape from the strong gravitational pull of a pulsar, one would have to fly almost at the speed of light.

Pulsars have diameters < 20km meaning they can be as small as s city!

Astrophysicists around the world

The Travelling Telescope (Kenya, Africa)
Susan Murabana Owen – the Kenyan astronomer, the US Space for Women mentor (2020/2021), the President of the African Planetarium Society, and also the CEO of The Travelling Telescope. The team takes their large portable telescopes and mobile planetarium to schools and public spaces, promoting the oldest science, astronomy, in Africa.

She Speaks Science (Worldwide)
Ghina M. Halabi - an astrophysicist and the founder of this project. The idea is to use storytelling to make science accessible, encouraging fresh perceptions about science and success, helping young people build a positive STEM identity. Furthermore, this project promotes women and minority scientists. They offer fun and engaging storytelling workshops at schools.

Bringing Astronomy to Rural Communities (Colombia)

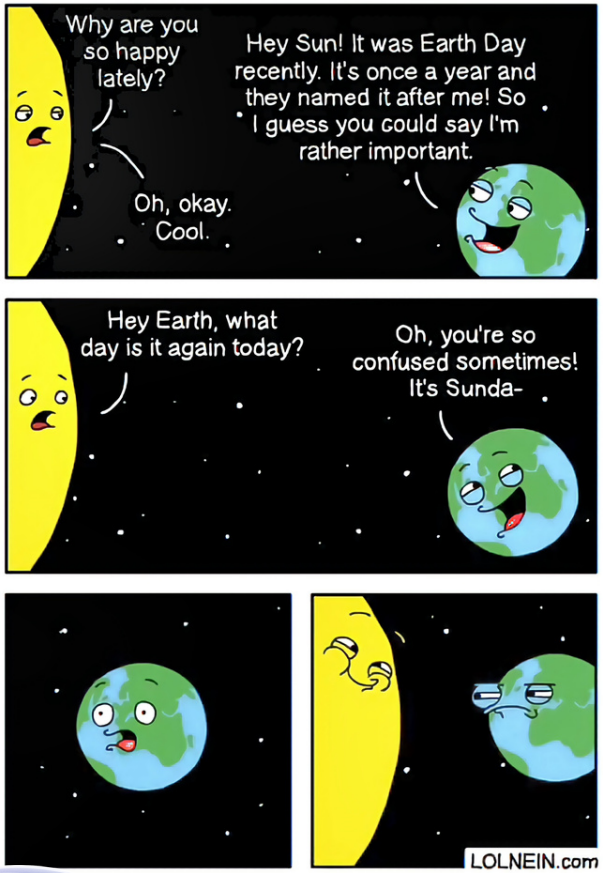
© NASA-Langley

This is a brand new project, which is going to send a box containing materials for conducting fundamental astronomy activities, games, and a USB drive with written and recorded instructions, and short interviews of Colombian astronomers. They will also motivate a final activity where each school makes a creative 'Voyager Golden Record' sharing their traditional customs and related astronomy knowledge. All these material will be uploaded to the website to share them around the world.

LAUGHING CORNER

A photon checks in at the hotel.
- Do you have any luggage?
- No, I am travelling light.

A very rare photo of the Milky Way viewed from Mars:



Hilarious!

How do you get clean in outer space?

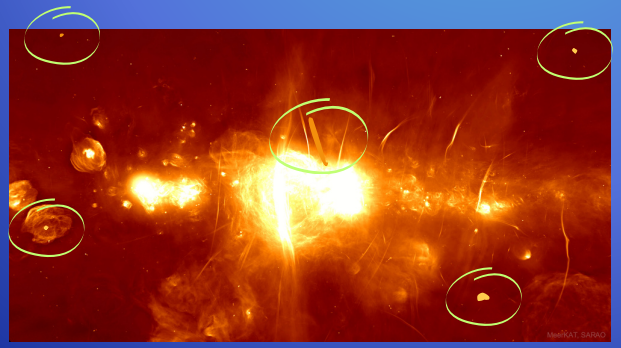
You take a meteor shower.

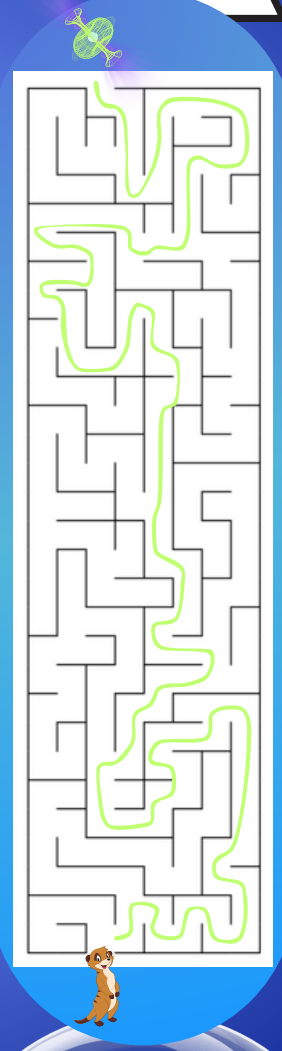
How do astronomers organise a party?

They planet.

SOLUTIONS

R	E	S	M	R	D	N	S	G	I	A	E	I	A
L	P	L	C	G	S	O	R	A	S	L	U	P	C
S	O	A	M	M	U	N	L	L	R	D	L	I	S
D	C	V	C	C	N	E	A	A	A	N	O	S	C
N	S	O	R	R	D	X	M	C	T	X	B	G	I
O	E	N	S	M	S	O	A	T	S	O	I	D	S
C	L	R	N	N	I	P	G	I	N	C	G	N	Y
E	E	E	B	E	D	L	N	C	O	M	R	R	H
S	T	P	I	O	M	A	E	P	R	S	A	O	P
I	O	U	N	O	C	N	T	L	T	T	V	O	O
L	I	S	A	X	S	E	A	A	U	N	I	R	R
L	D	N	R	N	N	T	R	N	E	I	T	L	T
I	A	D	Y	T	I	P	L	E	N	N	Y	P	S
M	R	I	D	S	T	M	E	E	R	K	A	T	A





What is an alien with three eyes called?

An aliiien!

What is an astronauts favorite key on the keyboard?
The space bar!

Imprint

This brochure was produced as part of the outreach activities in the international research project "TRAPUM - Transients and Pulsars with MeerKAT".

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