JULY 2020 | VOL8

CENTRE FOR ASTRO-PARTICLE PHYSICS

NEWSLETTER OF THE CENTRE FOR ASTRO-PARTICLE PHYSICS

UNIVERSITY OF JOHANNESBURG

EIGHTH EDITION

DATE: 13-07-2020

Designed by Jessica-Sheay Verrall

MESSAGE FROM THE DIRECTOR

The COVID-19 pandemic is one of the most influential events in the living memory of many of us. It has changed routine activities in most sectors and academia is not an exception. Teaching and learning has taken a new path when the lecturers and learners cannot meet in a classroom, but only in virtual rooms. While distant teaching and learning posed difficulties for lecturers who are only used to give lectures on a whiteboard in front of students, it also gave them an early warning of what might become the new norm in higher education in future. The resilience of our higher education system is being tested as never before and I must say that the pandemic has not stopped our pursuit for knowledge.

Resilience of the scientific communities during the pandemic is remarkable in research too. Virtual conferences replaced in-person scientific events and in many cases increased participation. While the pros and cons of virtual conferences are debatable; and to many, meeting in person is invaluable; it is clear that there will be more virtual conferences in future. Members of the CAPP participated in virtual conferences of all three collaborations that they are part of, namely, the Fermi Gamma-ray Space Telescope, the Cherenkov Telescope Array and the KM3NeT Neutrino Telescope.

Physicists and Astronomers have also engaged in COVID-19 research and helping communities by producing life-saving ventilators for hospitals to engage stay-home students with outreach activities. A list of activities by Physicists and Astronomers has been compiled by the IAU Office of Astronomy for Development. The arXiv.org, world's largest e-print archive has introduced separate tracks to easily find COVID-19 related research articles.

Finally, I would like to point out a global movement against racism in academia. On June 10, 2020, a large number of scientists across the world participated in an academic strike. Instead of carrying out regular teaching and research activities they reflected upon and discussed with colleagues-students about racial practice in academia and how to curb that. You may find more information in the following websites:

https://www.particlesforjustice.org
#ShutDownSTEM, #ShutDownAcademia & #Strike4BlackLives

I emphasize that CAPP fully supports equitable opportunities for people in academia and elsewhere regardless of their color or race. I hope you will enjoy reading the rest of the newsletter.

Picture of the virtual Consortium Meeting of the Cherenkov Telescope Array (CTA) Consortium

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FURTHER YOUR STUDIES

Scientists and students at the Centre for Astro-Particle Physics focus on research in Gamma-ray Astrophysics, Neutrino Astrophysics, Neutrino Physics and Gravitational Wave Physics. We perform theoretical studies as well as data analysis and modelling. All three experimental facilities that we are involved in, namely the Fermi Gamma-ray Space Telescope; the Cherenkov Telescope Array and the KM3NeT Neutrino Telescope, perform cutting edge research. Thus, working at CAPP can provide students and postdoctoral fellows opportunities to get involved in the science of these state of the art experiments, learn the latest techniques and interpret data collected with various instruments..

Cutting edge research by CAPP group members.

Research in Astro-Particle Physics requires strong background in Physics, Mathematics and computer programming. Although some theoretical studies are still done on papers with pencils, numerical computations and simulations on computers are the main tools to make theoretical predictions these days. Data analysis and modeling also require significant computer skills and learning specialised software.

Students who would like to pursue postgraduate studies in Astro-Particle Physics should choose Physics and Mathematics for their BSc degree. The BSc Honours programme at the Department of Physics offer a wide range of advanced courses, including Astrophysics courses, that can prepare students for future MSc and PhD research in Astro-Particle Physics. Honours students also get a taste of research by doing a project that helps them to prepare for MSc and PhD studies.

A limited number of top-up bursaries are available for Honours, MSc and PhD students from the CAPP. Interested students should contact Ms Jessica-Sheay Verrall (capp@uj.ac.za) with their academic transcripts.

FOLLOW US

We now have a Facebook and Instagram page. Please help us grow by following us and sharing the news.

WEBSITE

You can view our website to see events, the latest news, images, and info regarding the research of our group members as they happen and when they happen.
www.uj.ac.za/capp

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FACEBOOK

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EMAIL

You can also contact us at capp@uj.ac.za

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FOR MORE INFORMATION

Email: capp@uj.ac.za

Thank you to those who participated!

DRAW ME A NEUTRINO NATIONAL COMPETITION CLOSED

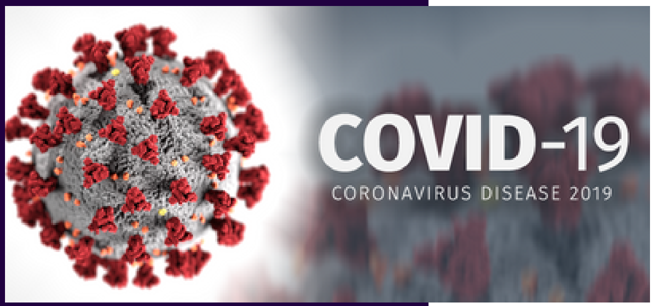
We will no longer be accepting entries for the competition. The entries will be viewed and a further announcement will be made at a later stage.

New dates of the 9th International Fermi Symposium

COVID-19 PANDEMIC

Due to the COVID-19 we have postponed the 9th International Fermi Symposium. The new dates for the symposium are **12-16 April 2021**.

We are closely monitoring the COVID-19 development, however, any further change will be communicated as soon as possible.



The latest news and discoveries

NEWS

The beating heart of a black hole

ScienceDaily. 2020. Black Hole's Heart Still Beating. [online] Available at: <https://www.sciencedaily.com/releases/2020/06/200610094108.htm> [Accessed 18 June 2020].

Detection of a Fast Radio Burst in Our Own Galaxy?

Starr, M., 2020. Exclusive: Astronomers Might Have The First-Ever Detection Of A Fast Radio Burst In Our Own Galaxy. [online] ScienceAlert. Available at: <https://www.sciencealert.com/a-galactic-magnetar-just-spat-out-something-shockingly-like-a-fast-radio-burst> [Accessed 18 June 2020].

Testing for dark energy and expansion of our universe? All we need is a starry night sky and its cosmic structures

ScienceDaily. 2020. New Test Of Dark Energy And Expansion From Cosmic Structures. [online] Available at: <https://www.sciencedaily.com/releases/2020/06/200603120551.htm> [Accessed 19 June 2020].

A mysterious meal for a black hole

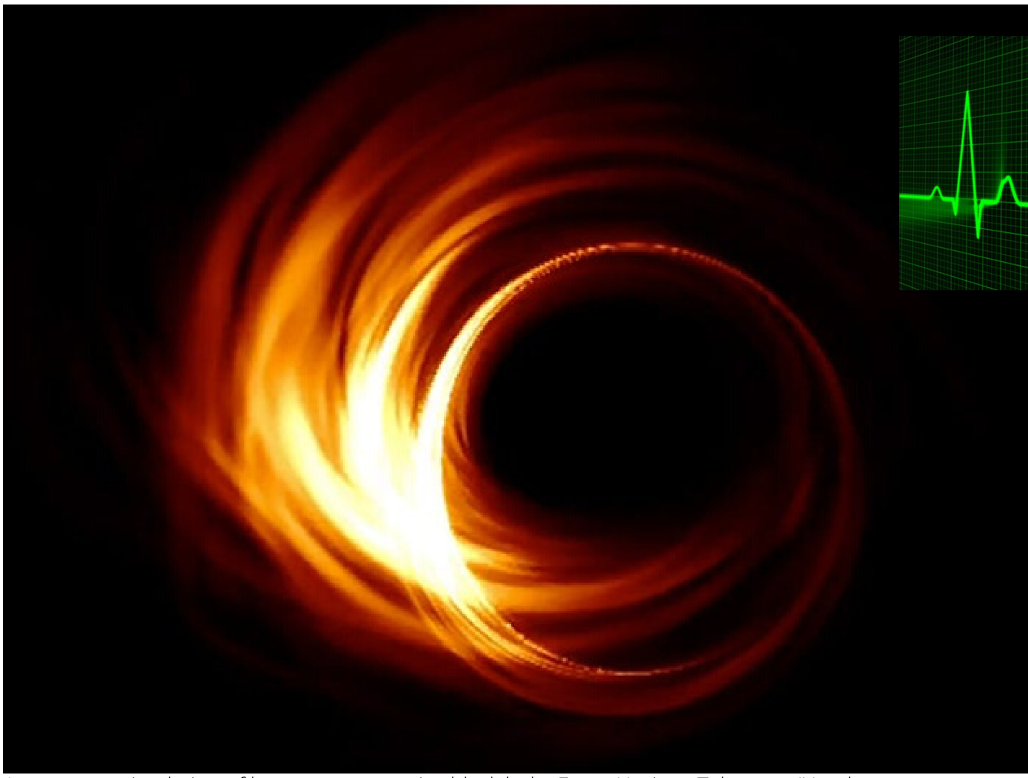
Drake, N., 2020. Mysterious Cosmic Object Swallowed By Black Hole Baffles Astronomers. [online] National Geographic. Available at: <https://www.nationalgeographic.com/science/2020/06/mysterious-cosmic-object-swallowed-by-black-hole-baffles-astronomers/> [Accessed 2 July 2020].

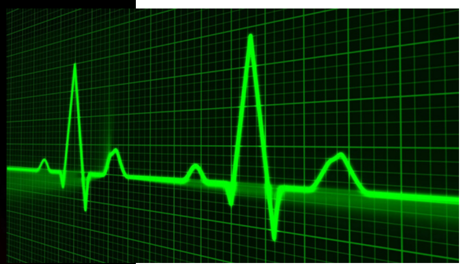
The beating heart of a black hole

A black hole's heartbeat reappeared after a number of years. In 2007 a black hole's heartbeat was detected at the centre of a galaxy called RE J1034+396 which is approximately 600 million light years from Earth. After its discovery the signal had been blocked by our Sun, until in 2018 the European Space Agency's XMM-Newton X-ray satellite was able to re-observe the black hole. According to astronomers this is the most long-lived heartbeat ever seen in a black hole. This heartbeat tells us more about the size and structure close to its event horizon.

The main idea for how this heartbeat is formed is that the inner parts of the accretion disc are expanding and contracting. The only other known system which appears to do the same thing is a 100 000 times smaller stellar-mass black hole in our Milky Way, fed by a binary companion star, with correspondingly smaller luminosities and timescales. This leads scientists to believe that even simple scaling's with black hole mass, work for the rarest types of behavior.

These signals now provide scientists the opportunity to further investigate the nature and origin of this very strong and persistent heartbeat signal. The next step in the research will be to perform a comprehensive analysis of this intriguing signal and compare it with the behavior of stellar-mass black holes in our Milky Way.





A computer simulation of how a supermassive black hole. Event Horizon Telescope/Hotaka Shiokawa

Detection of a Fast Radio Burst in Our Own Galaxy?

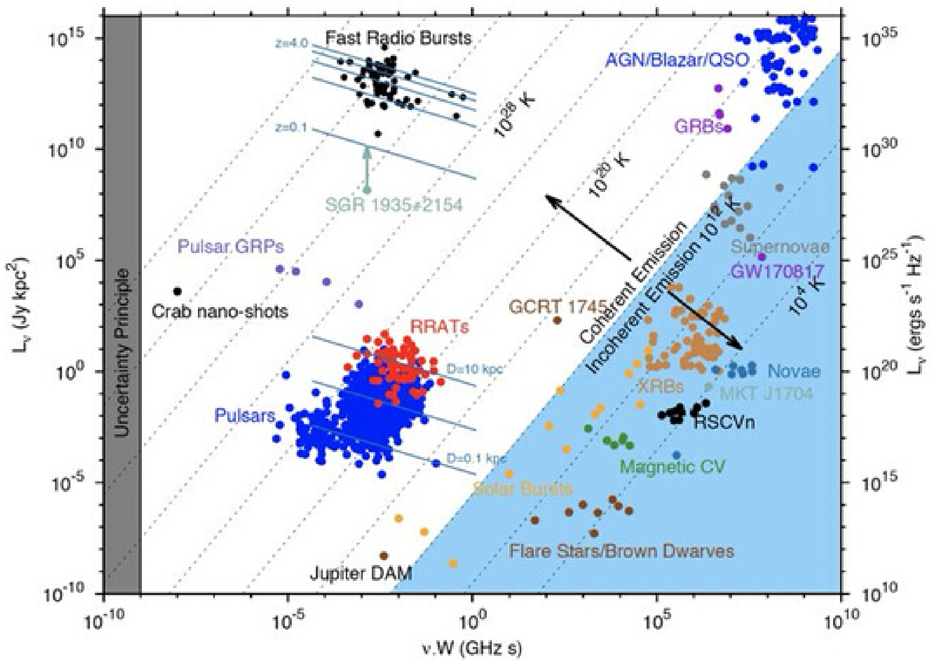
On the 28th of April this year, a dead star, sitting approximately 30 000 light-years away, was recorded by radio observatories around the world. Seemingly flaring with a single, millisecond-long burst of incredibly bright radio waves that would have been detectable from another galaxy. Not only were the radio waves recorded but they were accompanied by a very bright X-ray counterpart. Scientists are hoping that this information could lead to the source of fast radio
bursts (FRBs).

The radio bursts are extremely powerful radio signals from deep space, some of them discharging more energy than 500 million of our Suns. On the other hand, they only last for the blink of an eye which makes them very difficult to predict, trace, and therefore understand.

Scientists are theorizing that these FRBs are coming from magnetars. Magnetars are an odd type of neutron star, which are the extremely dense core remnants left over after a massive star goes supernova. Magnetars have much more powerful magnetic fields compared to ordinary neutron stars.

It is quite common for magnetar outbursts to emit X-ray emission, but not so much radio waves. The X-ray counterpart to the SGR 1935+2154 burst was not particularly strong or unusual but it could imply that there's a lot more to FRBs than we
can detect. These results lead scientists to evaluate the association between FRBs and magnetars.

The next step for scientists will be to analyze the spectrum of the burst and determine if it bears any similarities to the spectra of the extragalactic fast radio bursts. This will help scientists determine if magnetars are a source for fast radio bursts, however, it will not be the only one.



O Cathain, E., 2020. Transient Phase Space Plot Now With The SGR 1935+2154 Lower Limit From STARE2. [image] Available at: <https://pbs.twimg.com/media/EWyTsnBXkAYizgd?format=jpg&name=small> [Accessed 18 June 2020].

Testing for dark energy and expansion of our universe? All we need is a starry night sky and its cosmic structures

A recent study has found a new method in order to measure the direct effects of dark energy driving the accelerated expansion of the universe. This study uses a method based on a combination of cosmic voids (large expanding bubbles of space containing very few galaxies) and the faint imprint of sound waves in the very early Universe, known as baryon acoustic oscillations (BAO). These can be seen in the distribution of galaxies.

This new method gives much more precise results compared to the previously used methods. Previously, in order to measure the effects of dark energy, a technique based on the observation of exploding massive stars, or supernovae was used.

The study made use of data from over a million galaxies and quasars gathered over more than a decade of operations by the Sloan Digital Sky Survey. The results obtained confirm the model of a cosmological constant dark energy and spatially flat Universe to unprecedented accuracy. The results also strongly disfavor recent suggestions of positive spatial curvature inferred from measurements of the cosmic microwave background (CMB) by the Planck satellite.

These results, therefore, show the power of galaxy surveys to pin point the amount of dark energy and how it evolved over the last billion years. Research fellow, Dr Seshadri Nadathur, also stated that the study reported a new precise measurement of the Hubble constant.

It can be seen that the tentative evidence that data from relatively nearby voids and BAO favour the high Hubble rate seen from other low-redshift methods, but including data from more distant quasar absorption lines brings it in better agreement with the value inferred from Planck CMB data.

Starry night sky (stock image).Credit: © clearviewstock / stock.adobe.com

A mysterious meal for a black hole

On August 14th 2019, sensitive detectors (LIGO-Laser Interferometer Gravitational-wave Observatory & Virgo-In Italy) recorded minuscule perturbations of gravitational waves. This is an indication of some cosmic merger. About 800 million light-years away, a black hole consumed an unidentified object. The energy released from this merger was enough to wrinkle the fabric of spacetime.

The collision (called GW190814) stands out from the other dozen cosmic mergers. It was determined by Astronomers that one of the objects was indeed a black hole with as much as 23 solar masses. The other object, however, was devoured whole, sitting at roughly 2.6 solar masses. The smaller object being the mystery object which defies any definition, sits right between having a surface, like a star, and being a black hole. Its mass places it in a cloudy zone between the heaviest known neutron stars and the lightest black hole.

A neutron star is formed when a star explodes in a supernova, it is the stellar corpse that is left over after. A black hole is formed when a stellar remnant is compact enough to collapse into a point of infinite density. The main objective will be to figure out where neutron stars end and black holes begin. For Astronomers it is very tantalizing to find out
the truth, because one day when all the stars burn out these exotic objects may be the only things left drifting through an otherwise vacant universe. Unfortunately the system is too far away for other observatories to study.

For now, in this merger, it is not clear whether the black hole cannibalized another black hole, or whether it snacked on a neutron star. Therefore, this merger is particularly remarkable because they are so mismatched. There are endless possibilities and many unknowns linger, but scientists are taking into consideration as many scenarios as possible and will hopefully be able to draw some conclusions which could reveal how matter behaves in the universe's most extreme conditions.

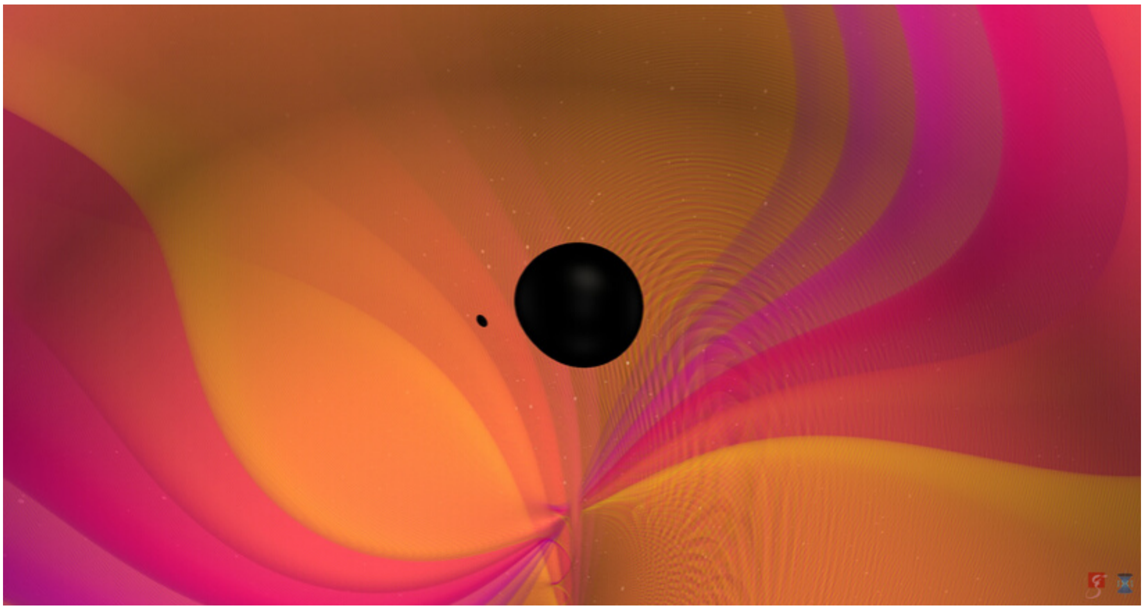


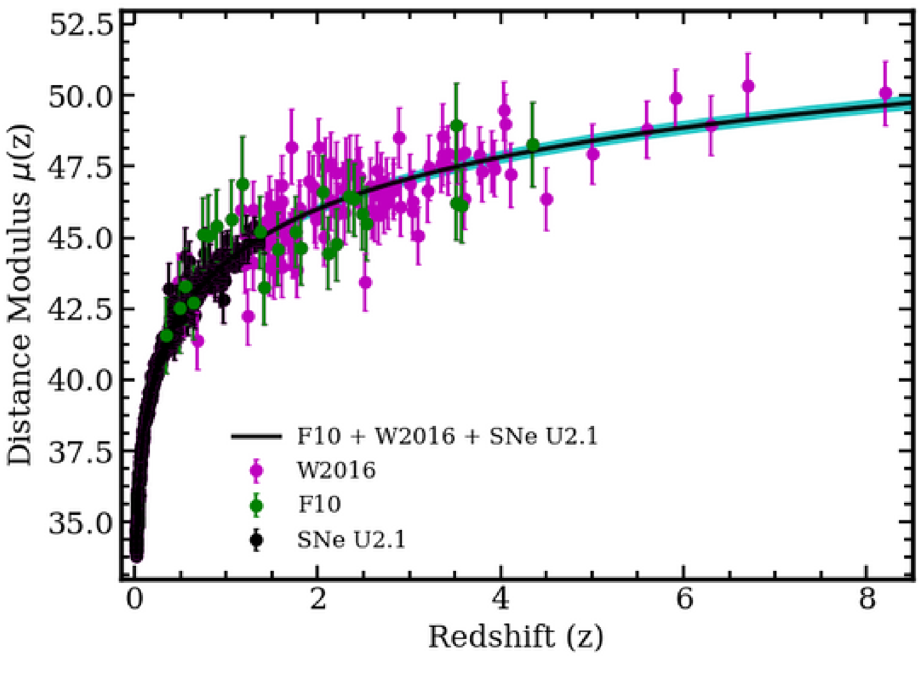
IMAGE BY N. FISCHER, S. OSSOKINE, H. PFEIFFER, A. BUONANNO (MAX PLANCK INSTITUTE FOR GRAVITATIONAL PHYSICS), SIMULATING EXTREME SPACETIMES (SXS) COLLABORATION

Research from our Centre

Dr. Feraol Fana Dirirsa

Since two decades, after the discovery of gamma-ray bursts (GRBs) phenomenological correlations among the spectral parameters of the prompt emission and it's energetic or luminosity, GRBs have been proposed as standard candles to constrain the cosmological parameters up to very high redshift -- beyond the current redshifts of cosmic voids, BAO, CMB, and supernovae. However, the most debatable issue in GRB concern is the existence of correlations, only the less scattered correlations can be used to precisely constrain cosmological parameters.

Using the parameters obtained from the correlation fits, researchers at the Centre for Astro-Particle Physics (CAPP) have been working to build the extended Hubble diagram, constrain the cosmological dark-energy parameter and the Hubble constant in the flat ΛCDM model with GRBs observed by the Fermi-Large Area Telescope (LAT) and other onboard Telescopes. The study uses the sample of GRBs alone and together with the latest Supernovae type-Ia data. The obtained results are consistent with the currently acceptable ranges of those cosmological parameters within errors. Employing a larger sample of GRBs may improve the statistical accuracy of the results. Currently, our research group uses the largest data set of cosmological GRBs known to date over a broad energy band to analyze the prompt phase-related empirical correlations, which can be used for the better estimation of cosmological parameters as well as improvising the accuracy.



The Hubble diagram for the combined GRB samples of F10 and W2016 with the latest Supernovae type-Ia data (SNe U2.1). The black lines are plotted using the estimated cosmological parameters obtained from the joint F10 + W2016 + SNe U2.1 data with 1σ confidence regions (cyan).

Journal reference link: https://iopscience.iop.org/article/10.3847/1538-4357/ab4e11

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ASTROPHYSICS THEMED WORD SEARCH

Have a go at our new astrophysics themed word search.

Astrophysics word search

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

ASTROMETRY
CONTINUUM
DOPPLER
ECLIPSE
GALAXY
HUBBLE
NEUTRINO
NUCLEOSYNTHESIS
PULSAR
QUARK
QUASAR
SUPERNOVA
PANDEMIC
SANITIZE
DISTANCING

VIRUS
FEVER
DRY
COUGH
TIREDNESS

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