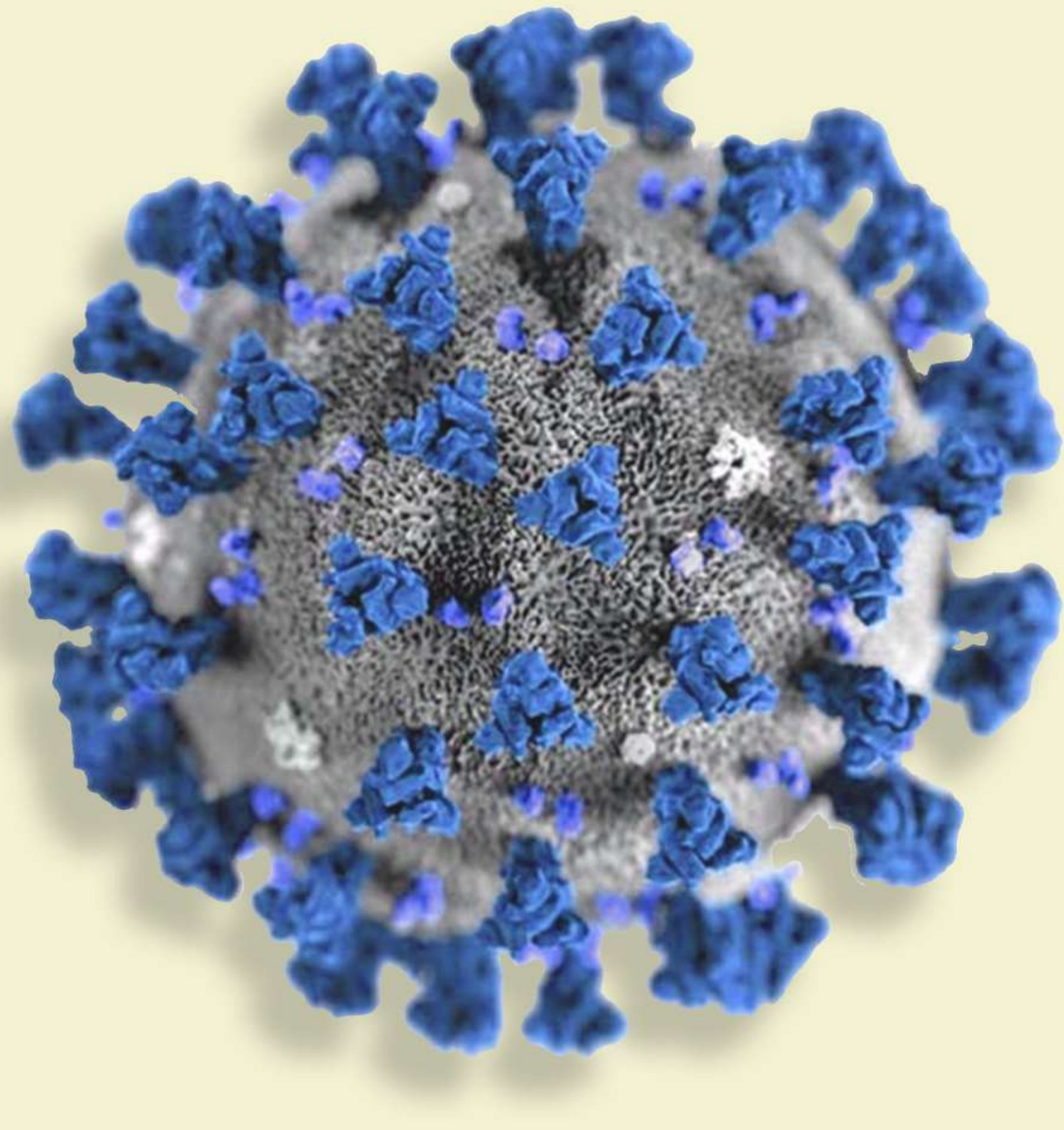
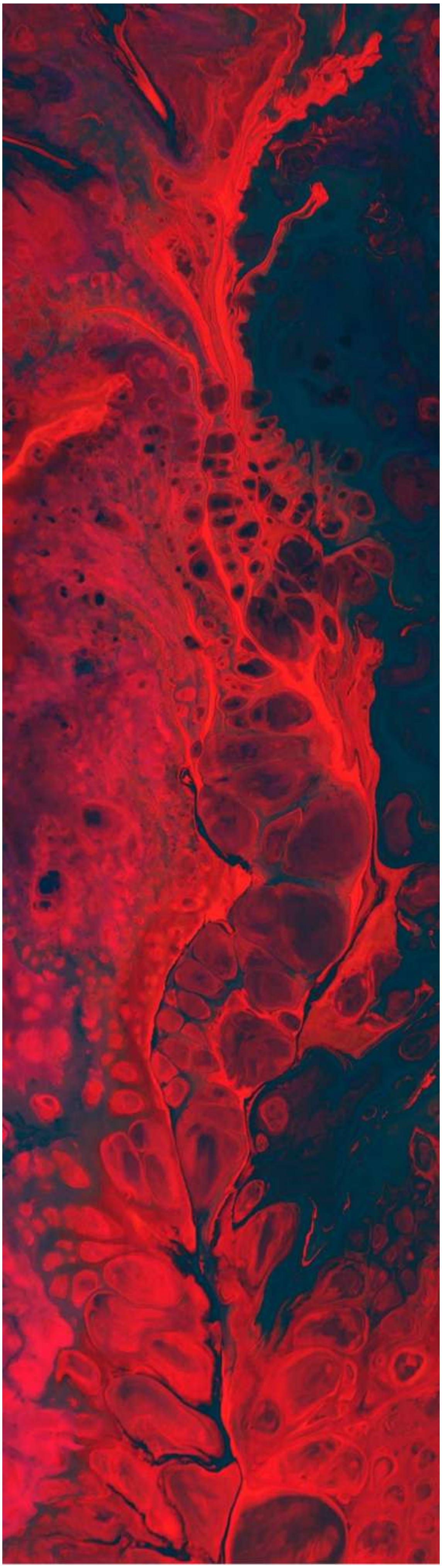
CHRYSALIS

Quarantine Edition



How screwed are we?
A comparative study of various outbreaks of the 21st century

A Silver Lining
Here's how our environment is recovering amidst this chaos



CHRYSALIS

Quarantine Edition

F E A T U R E S

A Note from the Editor

Dear Reader,

Welcome to the quarantine edition of Chrysalis, IISER Bhopal's very own science magazine. This edition was conceived to give you something to read while in lock-down/vacation, but more than that, it was to provide some work to our bored editors and designers :P.

Honestly writing, this edition was never meant to see the light of day (or the inbox of any mail). Chrysalis was almost ready to go online, as a blog on the students.iiserb website. But then, the COVID-19 pandemic struck and for some reasons, now we are unable to go online until the semester starts. But, the show must go on, and this edition is a small act of defiance against the virus. Whatever it throws at us, we won't bow to it.

On this happy note, I'd like to highlight some of the articles in this edition. One is written by Mr. Bijoy Dey, a fourth year PhD student who tells us about his work in the Molecular Magnetism Lab. I take this opportunity to make a humble appeal to all the Ph.D. students and post-docs to write to us about their work. We would love to publish it. Another article I would like to mention is an original comparison between the COVID-19 pandemic and other outbreaks of the 21st century written by Mansi Bhati (3rd year BS-MS).

As always, the Chrysalis team welcomes articles from the IISERB community. If you are interested to contribute to Chrysalis, please do write to me at vyom18@iiserb.ac.in and we'll figure out how to proceed.

Thank You.
Vyom
Editor, Chrysalis

The dimming of the Red Supergiant

How Orion's shoulder tried to be humorous

By Abhisek Swain

A bright red star embedded in the shoulder of the Orion Constellation started to dwindle in its brilliance back in October 2019. Edward Guinan and Richard Wasatonic, two astrophysicists at the Villanova University, Pennsylvania and their team first noticed this abnormal dip in its brightness. Within a span of 4 months the star had dimmed to one fourth of its original brightness. By mid-February 2020, it had become the 24th brightest star in the night sky, falling down 14 places from being the 10th brightest star 4 months ago. Betelgeuse had never fluctuated by this magnitude in its astronomical records.

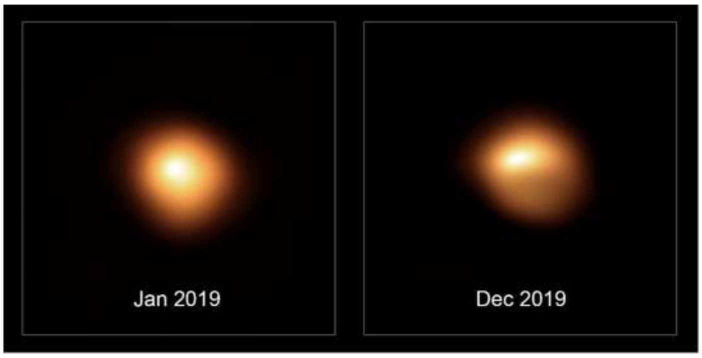
Betelgeuse is a red supergiant, a stage in the life cycle of high mass stars between 10 and 40 solar masses. Dwarf, Giant and Supergiant are classes that astronomers assign to stars based on the total amount of light they emit in a fixed time interval. Dwarves are fainter than giants and supergiants emit more light than giants. Betelgeuse is colossal. It has a radius 900 times that of our Sun. Imagine that Betelgeuse and our sun have switched places,with it's centre located where the sun's centre once lied. Then, the radius of Betelgeuse would extend beyond the orbit of Jupiter, thus engulfing Mercury, Venus, Earth, Mars, Jupiter, all their moons and roasting Saturn and it's icy moons to a crisp.

Betelgeuse is extremely luminous. Luminosity is the intrinsic brightness of an object independent of the distance from which it is measured.To put into perspective, imagine two identical candles one closer to you and the other at a distance, the former will look brighter while the latter will be dimmer, but they still have some property that is equal which is their luminosity. They produce the same amount of light. Stars appear dimmer than a torch, because they are very far away even though a star emits unfathomably more light. Thus we could say that a star is more luminous than a torch but a torch is brighter. In that respect, Betelgeuse outshines the sun between 90,000 and 150,000 times.

> ***"Massive stars live aggressively and die violently...They end their lives with a cataclysmic burst called a supernova, dispersing their chemically enriched interiors across the neighbourhood."***

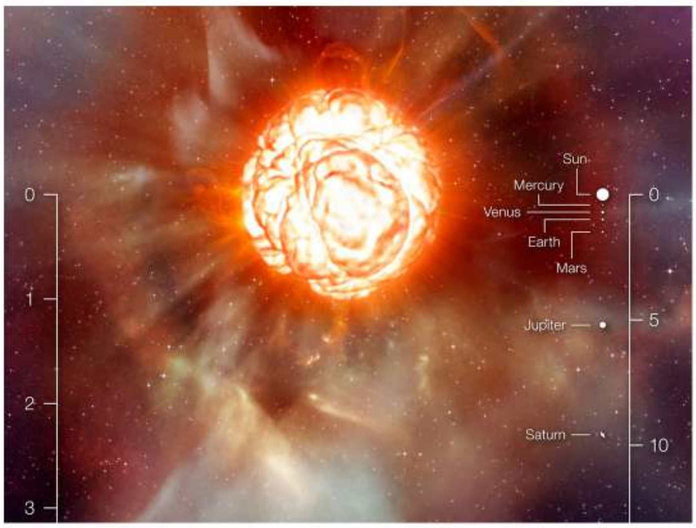
Massive stars live aggressively and die violently. They quickly tread through various stages of their stellar life cycles, rapidly burning off their hydrogen fuel and fabricating heavier and heavier elements till their mass permits. They end their lives with a cataclysmic burst called a supernova, dispersing their chemically enriched interiors across the neighbourhood. The star held between 15 and 25 times the sun's heft when it was a main sequence star about 40,000 years ago hence falling into the category of high mass stars.

Betelgeuse is a toddler amongst stars in cosmic terms. It is only 8 million years old and is already on the verge of ending it's brief life in a supernova in about 100,000 years.The sudden plunge in its brightness sent a wriggle of excitement through the astronomy community worldwide, hinting at the likelihood of an early supernova, possibly within our puny life times. But in late February, the brightness began to increase and has been increasing since then, killing the hopes of witnessing an incredibly rare spectacle. Astronomers measure brightness in units called apparent magnitude which is reverse logarithmic. It means an increase in apparent magnitude corresponds to a decrease in brightness. It is analogous to the pH scale in which a higher pH indicates a lower acidity. A difference of 5 apparent magnitudes is parallel to a 100 fold difference in brightness. Doing the math, a 1 magnitude increment says that the brightness escalates by a factor of 2.51. The dimming of the star had all the astrophysicists puzzled. The brightness had dropped to a magnitude of +1.12 on December 7 from +0.65 in September, 2019. It fell to +1.50 on January 18 setting a new



record in the last 100 years. It registered a historical minimum of +1.61 on January 30, 2020 nearly equalling the brightness of the star Bellatrix in the same constellation. There are two possible explanations so far. One reason for the dimming could be internal changes in the star that could lead to decreased luminosity. For the simultaneous conservation of gravitational and thermodynamic energies inside the star, a decrease in size also reduces the luminosity. To physically interpret this, a star with a large surface area allows a substantial amount of light to escape it's surface while a small star with a small surface area has little room for light to escape copiously. Thus a decrease in luminosity corresponds to an increase in star size.

Plugging the numbers in, the star should have decreased by 8% in size to account for the plunge in luminosity. However, observations do not support this. Stars have convection cells that appear as dark patches on their surface forged in a process called "dredge up" wherein hot material rises from the core and cools at the surface.On the Sun these are numerous and small, about the size of France but on a red supergiant like Betelgeuse these cells are few and titanic in size , as big as the orbit of Mars. These cells, along with the rotation of the star cause semi regular variability in its apparent brightness. But no convection cell could explain the sheer drop that happened to Betelgeuse. The surface temperature of the star has been observed to have decreased by 100° C from 3650 to 3550 degrees. The star has cooled a bit, just not enough to be for evidence of convection cells causing this. No cell could explain the sheer drop that



happened to Betelgeuse. A more promising explanation is circumstellar dust. There could be

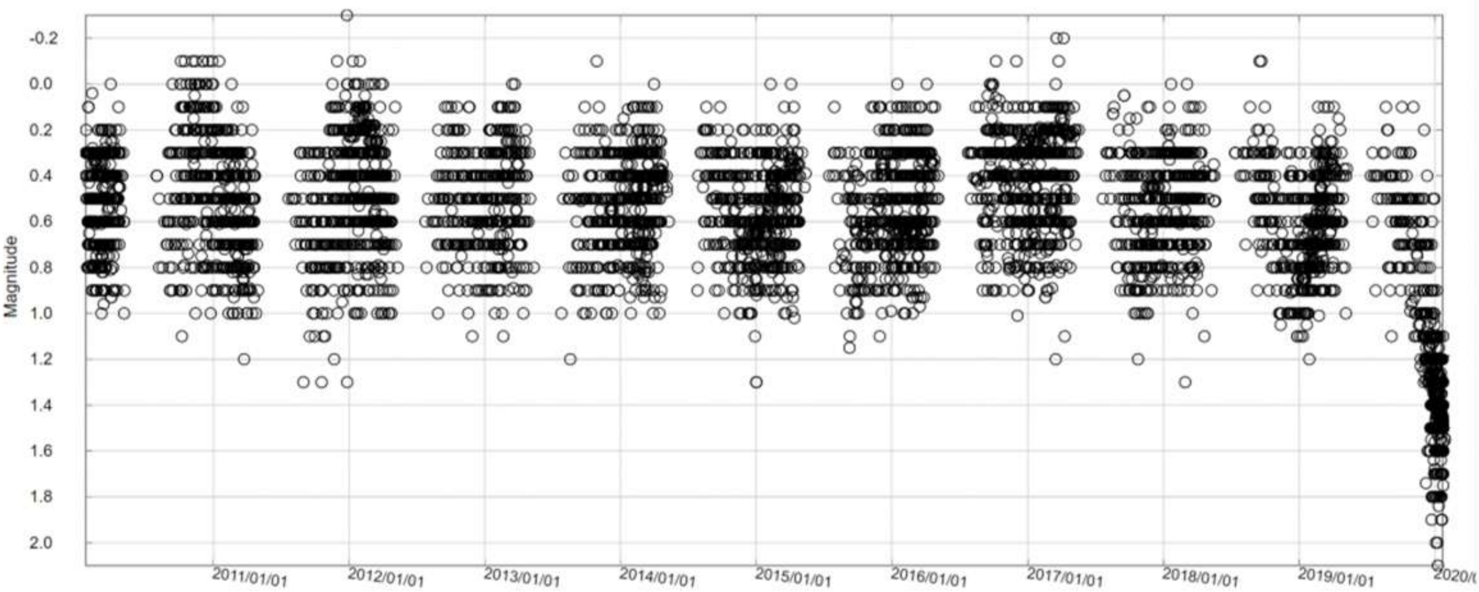


Figure: This is a plot of visual light observations of Betelgueuse from the AAVSO. Each black circle represents an individual observation from an individual member od AAVSO. There are nearly 8,000 separate observations. The plot starts in 2010 on the left and goes up to 2020, where there is a noticeable decline in visible light. Image credits: American Association of Variable Star Observers (AAVSO) and universetoday.com.

immense blobs of gas and dust surrounding the star that could simply absorb and block a significant part of the light from reaching us. These clouds of dust form when bursts of radiative pressure from the core as it contracts. Material from inside the star bubbles up to the surface smearing out in the vicinity of the star. Red giants lose mass by this process.This material then envelopes the star blurring the border between the surface and outer space Betelgeuse hence doesn't have a well-defined photosphere, it's body just gradually transitions into the Corona (ahem ahem!). Researchers Emily Levesque and Phillip Massey have looked up for titanium oxide that are ejected by red giants. Spectroscopy has shown an abundance of absorption lines of titanium oxide in the spectrum which is directly correlated with the surface temperature. By this method the temperature was calculated which didn't show as low a drop to support the former idea. This has led to their research paper being accepted worldwide and the latter explanation has been agreed upon.

Space weather forecasts have once again pushed the dates of the inevitable Betelgeuse supernova explosion to about 100,000 years into the future. Once it does, our descendants will be able to see it as bright as a full moon, visible even in the broad daylight. A time bomb ticking 700 light years away to set our night sky ablaze.

Comparison of COVID-19 to *other outbreaks of 21st century*

The juxtaposition of various outbreaks of the 21st century has been carried out based on different parameters. These charts and visuals account for the extreme behaviour of COVID-19 as compared to other epidemics

by Mansi Bhati

A lot remains unknown about the new novel coronavirus, but one thing is for certain that it has a huge potential to spread and cause damage globally. COVID-19 belongs to a family of coronaviruses. This family has just six more viruses that have affected humans in the past. Four out of which have constantly been bothering humans by causing around 1/3rd of common colds. Rest two, SARS (Severe Acute Respiratory Syndrome) and MERS (Middle East Respiratory Syndrome) had caused a lot of casualties in the past. However, they remained constricted to certain regions. What is so distinct about this coronavirus that it has now been declared as a pandemic?

I have compared the following major outbreaks of the 21st century based on different parameters.

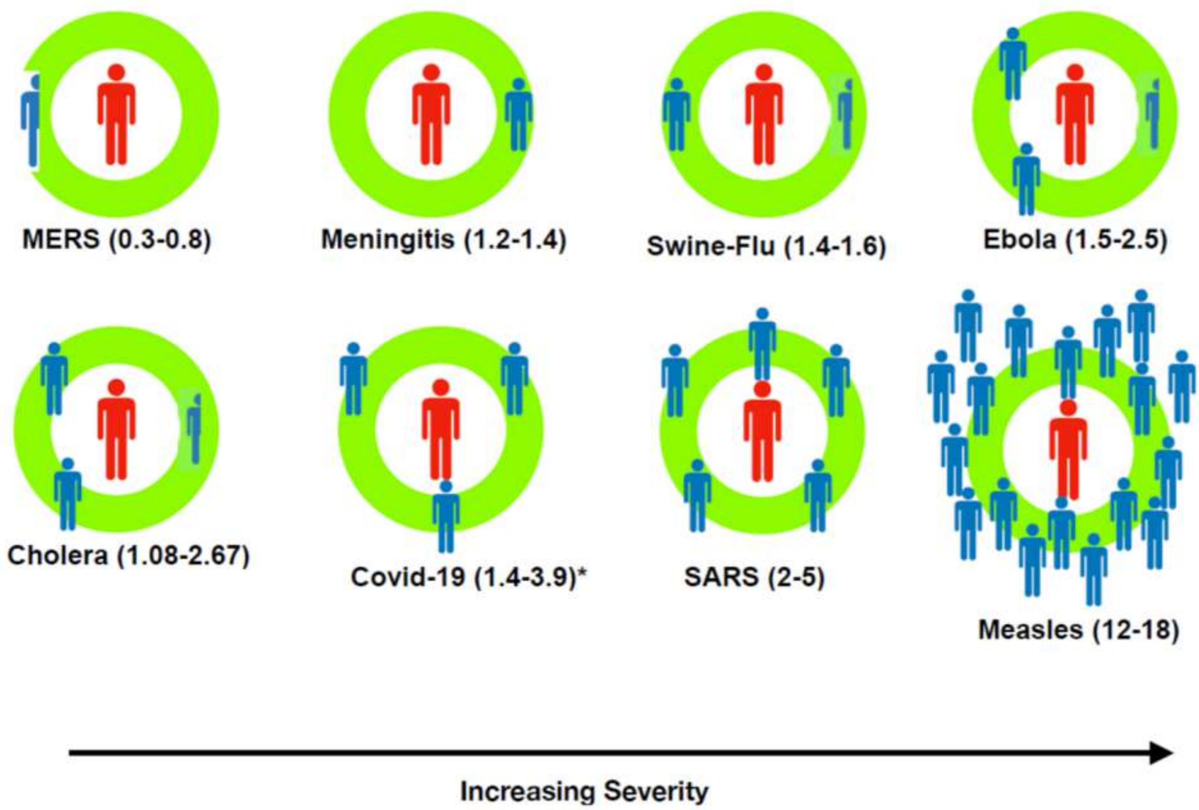
Epidemics	Origin (Virus/ Bacteria)	Cause(Suspected)	Transmission
COVID-19 (2020-)	SARS-CoV-2	Bats that spread it to smuggled pangolins in China.	Airborne Droplet
Ebola- West Africa (2014)	Ebolavirus	Fruit Bat	Body Fluids
Swine Flu (2009-10)	H1N1 Influenza Virus	Pigs	Airborne Droplet
SARS- China Hong-Kong (2002-04)	SARS-CoV	Bats that spread to civet cats	Airborne Droplet
Measles- DRC (2011-14)	Measles morbillivirus	Accumulation of unvaccinated, children susceptible to measles	Airborne
Meningitis- West Africa(2009-10)	*Neisseria meningitidis* bacteria	African Meningitis belt	Airborne
MERS (2012-now)	MERS-CoV	Dromedary camel	Airborne Droplet
Cholera (2010-13)	Bacterium *Vibrio cholerae*	Aribonite River in Haiti	Contamination of food or water

The parameters taken into consideration while comparing the various outbreaks are origin, mode of transmission, basic recproduction rate, case fatality rate, total number of deaths and geographical spread of the outbreaks.

R_0 Value (Basic Reproduction Rate)

R_0 , the Basic Reproduction number is the average number of people who are susceptible to an infection spreading from one contagious person. These are the people who haven't been previously affected by this infection and haven't been vaccinated.

According to initial reports, SARS-CoV-2 likely attacks the ACE2-bearing cells, lining our airways. This new strain of virus is so genetically similar to previous SARS virus, now called as SARS-Classic, that it inherited its title and is now called as SARS-CoV-2. The spikes on its surface bonds very strongly with the human cells, unlike the "SARS-Classic".

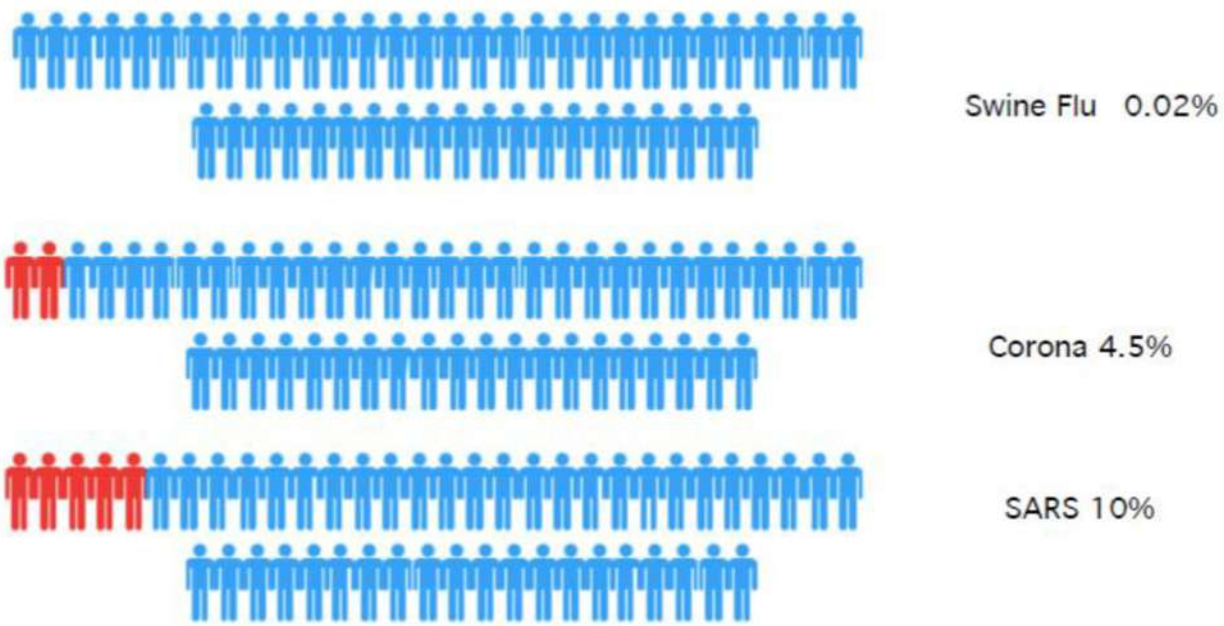


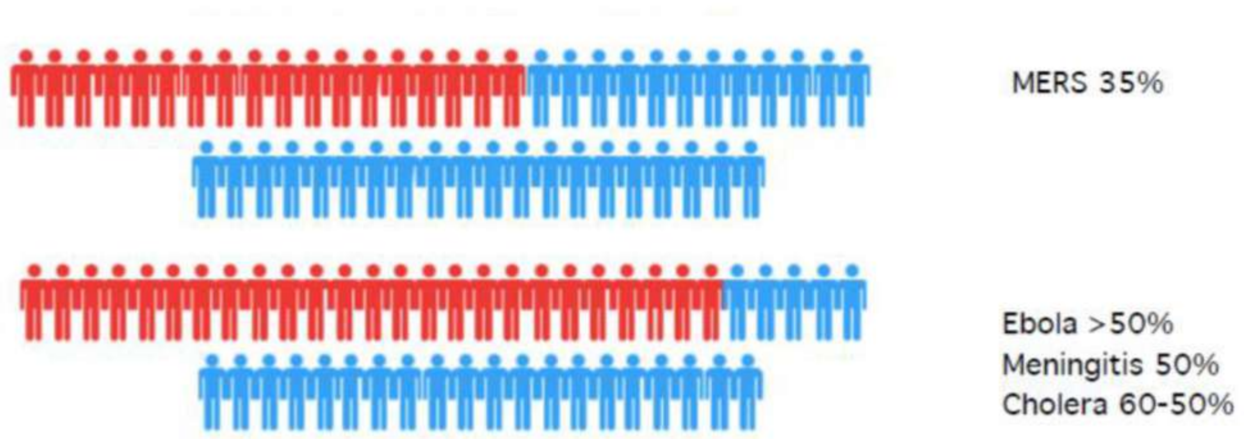
The tighter this bond will be, the fewer viruses would be required to start an infection. Also, according to some recent studies, the virus remains viable in air for 3 hours, on cardboard for 24 hours and on plastic and stainless steel for 2-3 days, which explains its high transmission rate.

Case Fatality Rate

$$\text{C. F. R.} = \frac{\textit{Number of people who died of that disease}}{\textit{Total Number of people who got infected}}$$

For every 50 people who are infected, the CFR values for the diseases in consideration are:

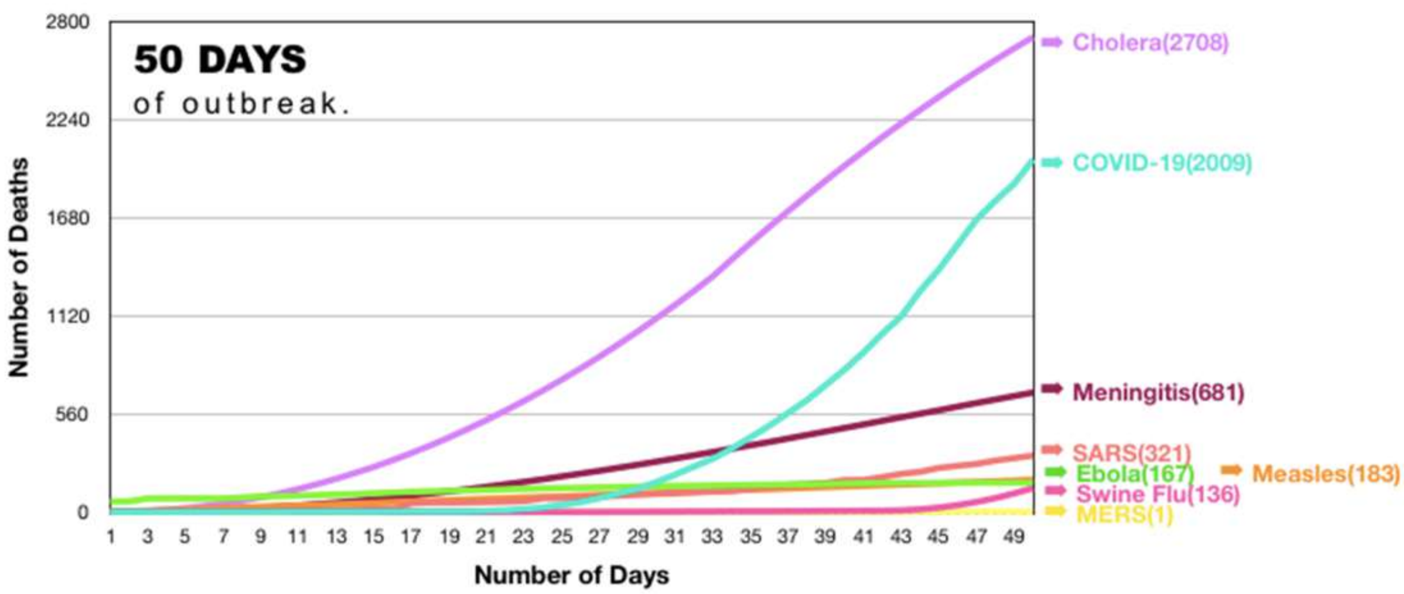


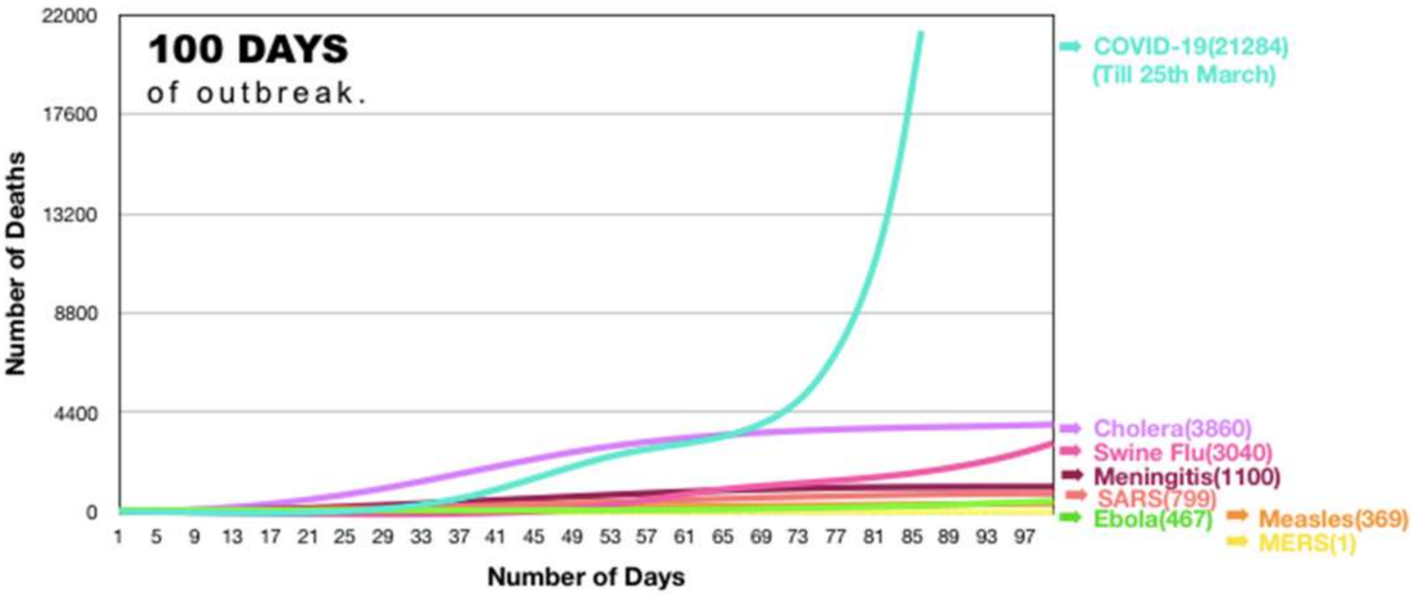


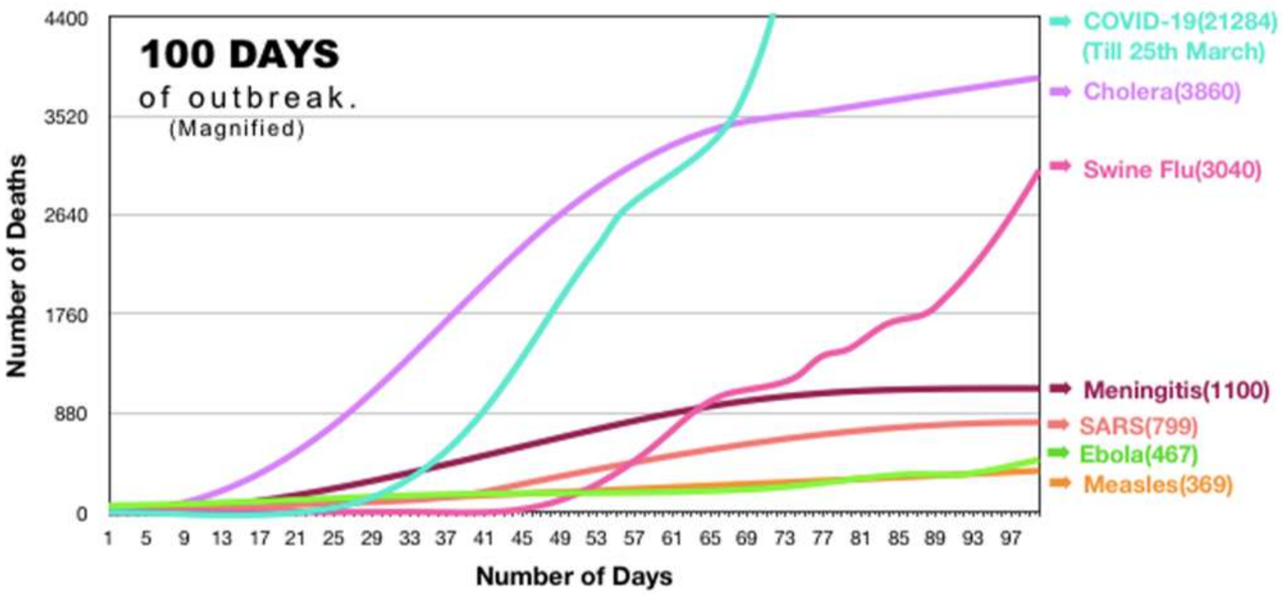
In general, respiratory diseases affect either our lower or upper air pathways. Upper pathway infections spread easily and are mild, while lower pathway infections are hard to spread and are severe. It is suspected that SARS-CoV-2 infects both our lower and upper pathway. This may be the reason why many people only show mild symptoms when its transmission is on its peak, making it dreadful to tame the fatalities.

Total Number of Deaths

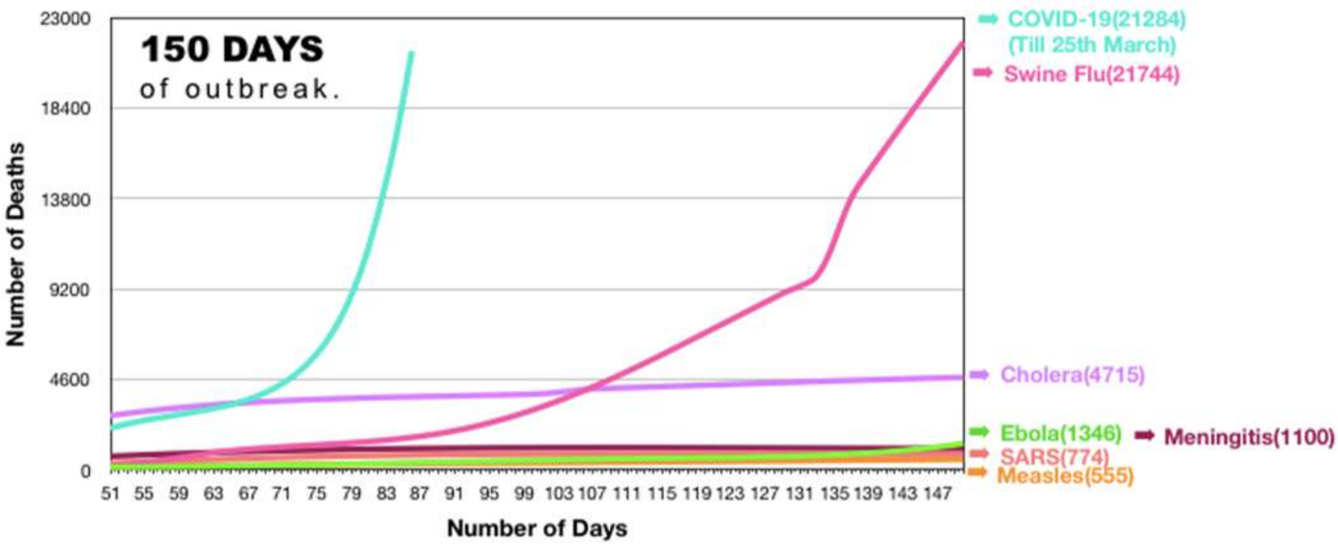
Here. I have compared the day-wise death tolls of various epidemics over a time period of nearly two years.



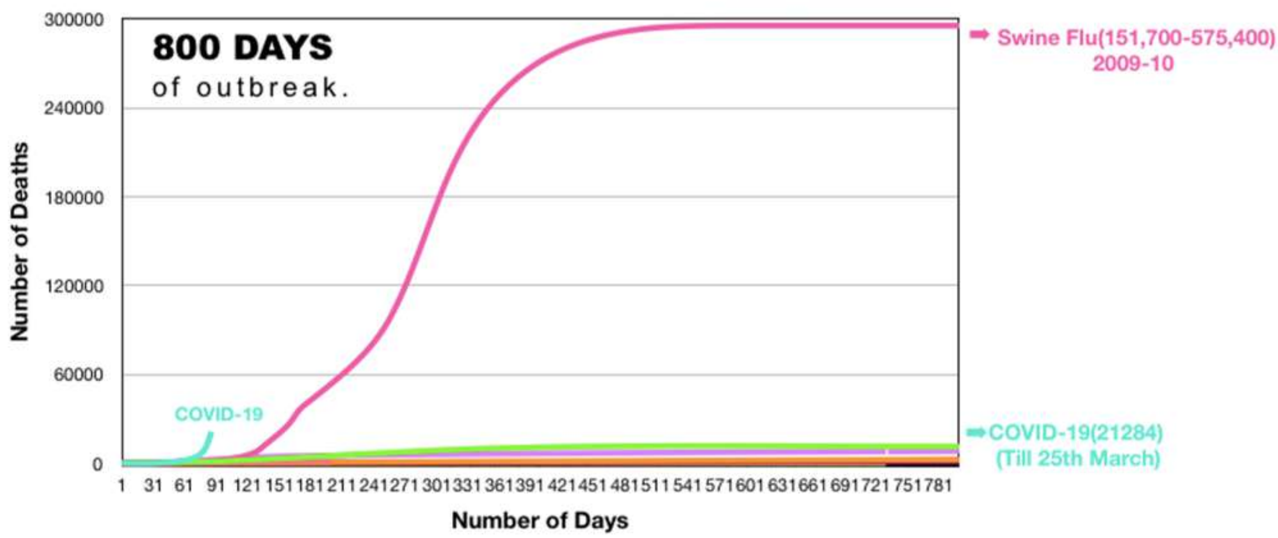




Here we see that just after 67 days of outbreak, COVID-19 has already overtaken the death tolls of all the previous epidemics and has shown potential to turn into a PANDEMIC.



As of today, 25th March 2020, the death toll of coronavirus has already become the quickest epidemic to cross the number of deaths than any other epidemic could approach in its entire span.



As we can see from this graph of Swine Flu and others in the magnified version of 800 days given below, all of them display a similar trend. During an outbreak, the number of people getting affected by a virus increases exponentially. However, if a disease is managed well then this number starts to decrease. Either the people who have been infected have already died or the people infected have developed immunity to such a virus.

The simplest mathematical tool to explain it is a Logistic equation which initially behaves like an exponential curve and eventually tapers off when the maximum population size has reached.

If the infection rate is to decrease, then

$$\frac{dP}{dt} = 0$$

Expanding this by Taylor's series,

$$\frac{dP}{dt} = a \, . \, P + b \, . \, P2 + c \, . \, P3 + \ldots .$$

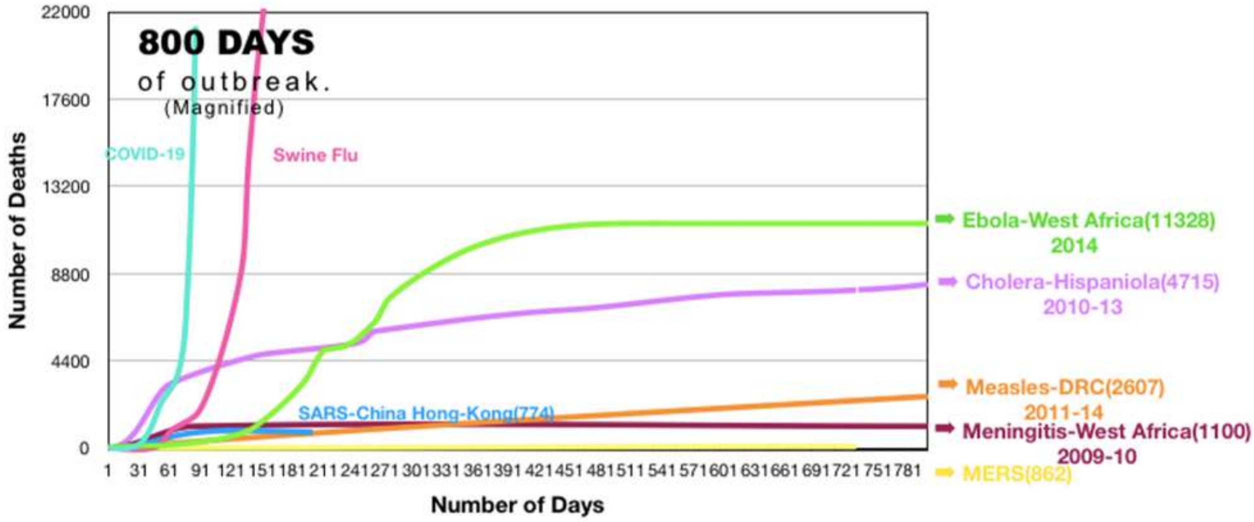
Taking the first two terms of this series will give us a non-trivial solution (taking only first term leads to an exponential equation).

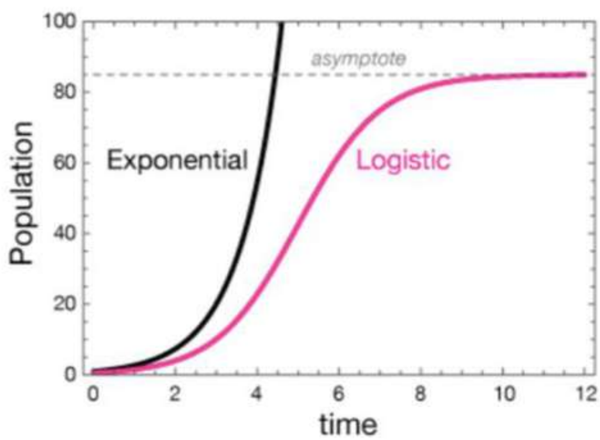
$$\frac{dP}{dt} = P \, (a + b \, . \, P) = 0$$

$$P = \frac{-\,a}{b}$$

So either a or b is negative, thus making the whole term negative. Re-writing it, we get the logistic equation.

$$\text{Growth rate} = \frac{\textit{Rate of infections}}{\textit{Number of infected people}} = \frac{dP/dt}{P} = a - b.P$$

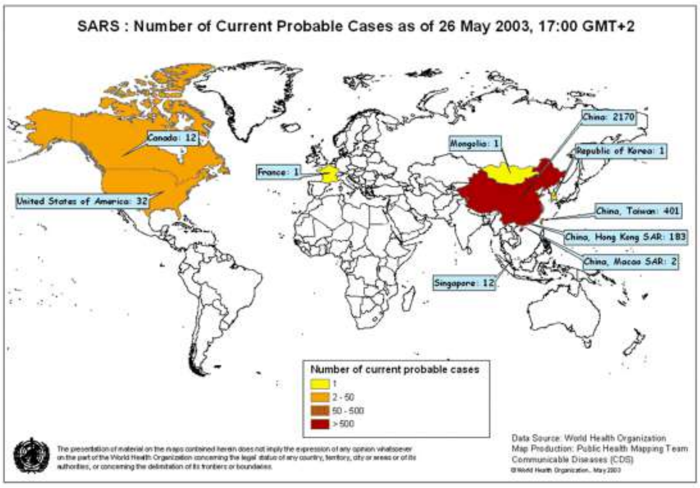




One can see from the above graphs that other coronaviruses like SARS and MERS took a longer time to gain momentum and caused a lot less damage than SARS-CoV-2.MERS virus actually took 8 years to infect the first 2,500 people, which COVID-19 had already crossed in its first month. It seems that for SARS and MERS to start infecting, it took a brief period of mutation to finally adapt to the human body, whereas

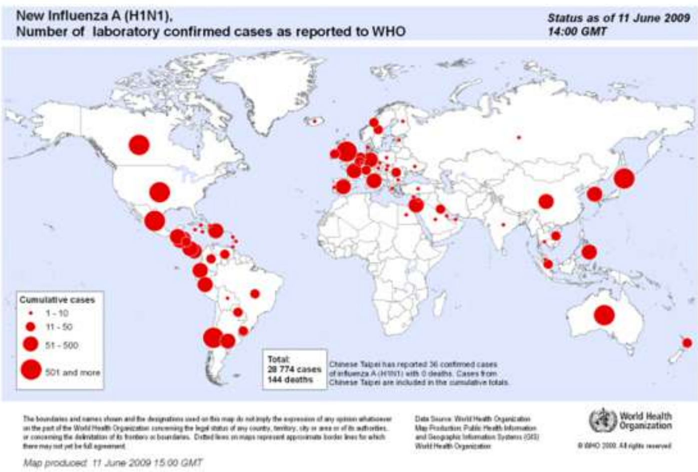
COVID-19 already seems to be an uncanny fit to the human body. Imagine the odds of that happening!

Geographical spread of the outbreaks

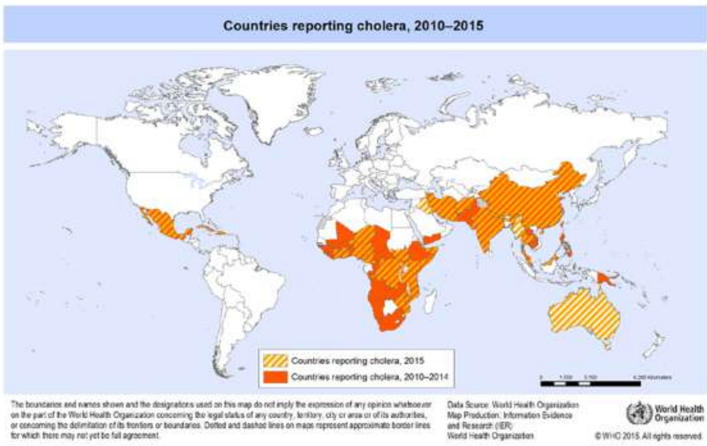


SARS

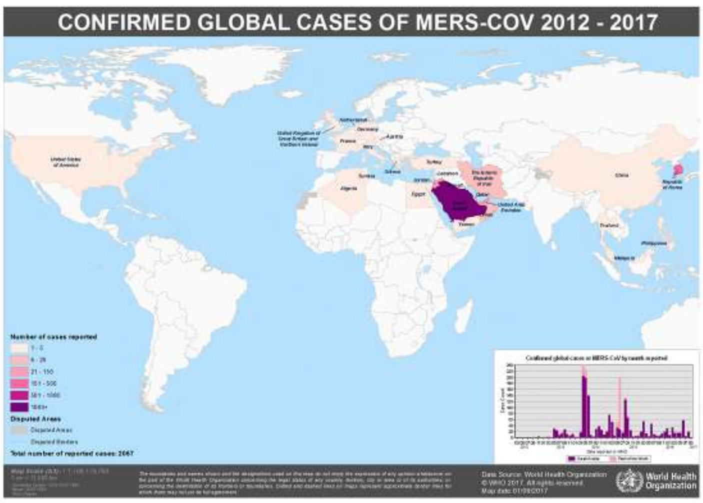
MENINGITIS



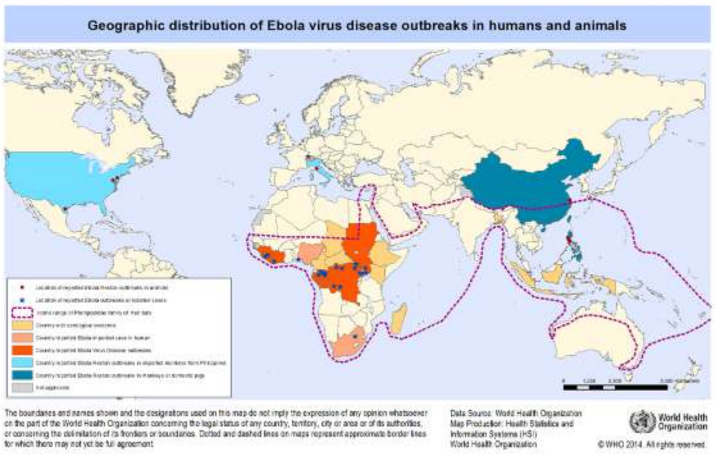
SWINE FLU



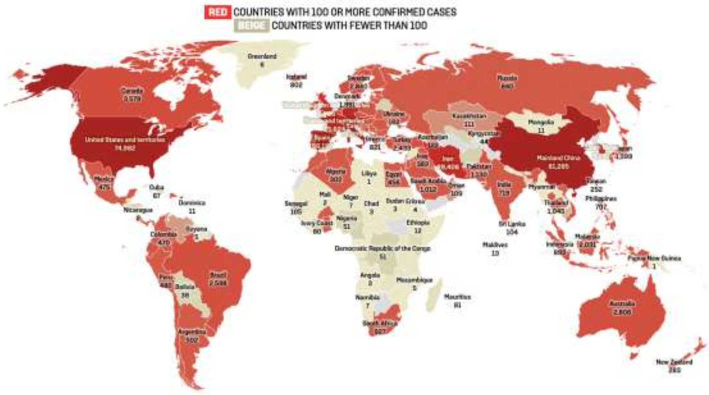
CHOLERA



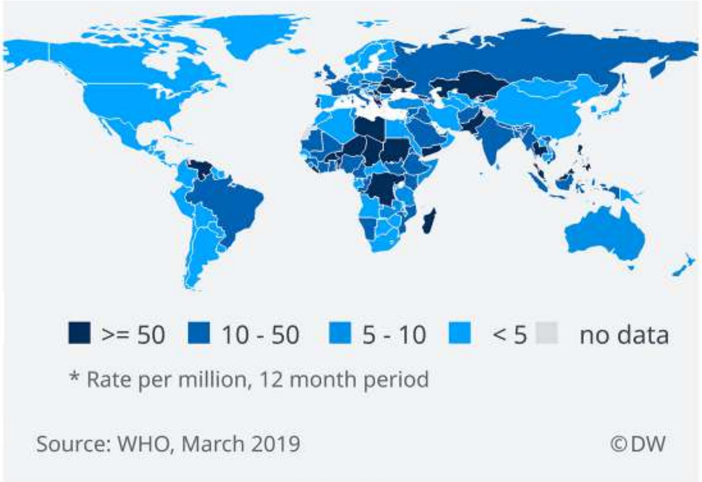
MERS



EBOLA



COVID-19



MEASLES

While all the epidemics were confined to some regions, COVID-19 has already spreadacross the globe. Some preliminary studies show that warmer temperatures and higher humidity may bring some relief to the situation. In cold and dry air, the liquid that coats our lungs become thinner, and the cilia which help in evicting viruses and foreign particles start beating slowly. Also, low humidity means that the sphere of moisture around the virus can hover in the air for a longer period of time because gravity won't pull it to ground. But in summer and humid weather the trends reverse. However, this doesn't guarantee that the new coronavirus will stop transmitting in summer, after all, it is readily transmitting in areas like Singapore(which is in the tropics) and Australia(where it is summer now). Summer alone can't save us unless we take down the virus by socially distancing ourselves.

WHO Director-General Dr. Tedros Adhanom Ghebreyesus said, **"We cannot say this loudly enough or clearly enough or often enough: All countries can still change the course of this pandemic,"**. The numbers and trends we saw above are not implacable. With the help of a coordinated response from the people, we can still curb the situation and save lives.

Sources:

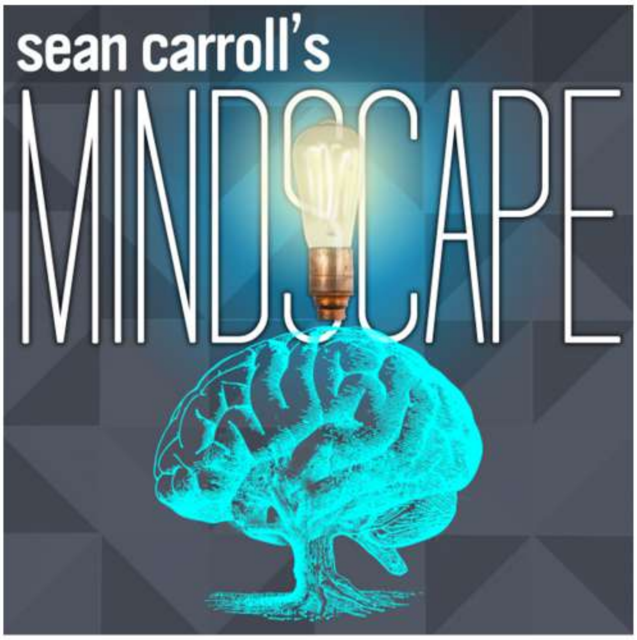
1. WHO Website.
2. CDC Website.
3. For Coronavirus data: https://www.worldometers.info/coronavirus/
4. For nicely documented death toll data: Cary production.
5. Article from The Atlantic: "Why the Coronavirus Has Been So Successful"

The *Mindscape* Podcast

by Krishna Prahlaadh R

For those who haven't heard the term before, a podcast is an episodic series of digital audio files that a user can listen to, either by streaming or by download. The Mindscape Podcast is a venture by physicist and Caltech professor Sean M. Carroll, who is popular in the physics community for his conversational and easily accessible textbook Spacetime and Geometry: An Introduction to General Relativity.

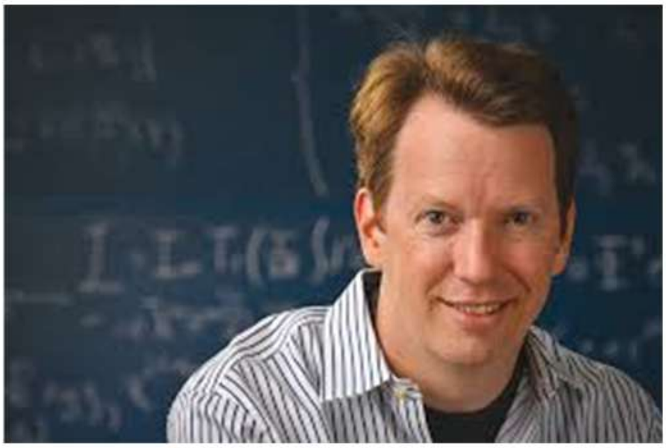
Carroll has been a science populariser for a few years now, alongside the likes of Michio Kaku and Neil DeGrasse Tyson. His style of science populariza-tion is unique in the wa that he doesn't tend to over-exaggerate OR cut down on too much of the details (which is probably why he isn't as popular as the other two). His talks, pop-sci books and podcast episodes tend to a somewhat more exclusive audience -those that aren't completely unfamiliar with science and want to know more about various different areas, while not completely sacrificing the technical details. He has a distinctive diplomatic approach to the topics he talks about, whereas most other popularisers rely on sensationalism to attract more attention to mathematical physics.



Carroll doesn't stop at physics - he goes above and beyond to get people from different walks of life on his podcasts. The very first episode, for instance, features Carol Tavris, who talks about cogni-tive dissonance, the psychological term associated with acceptance and rejection of opinions and expe-riences that are different from one's from one's own. One of the early episodes also features an astrophysics major-turned poker player who makes millions, and a philosophy professor-turned activist for liberal democracy. I haven't listened to more than ten episodes, but the majority of all of them take interdisciplinary to a whole new level, with Carroll attempting to make mathematical and physical connections to any subject of the conversation in a subtle and entertaining manner, without making it annoying.

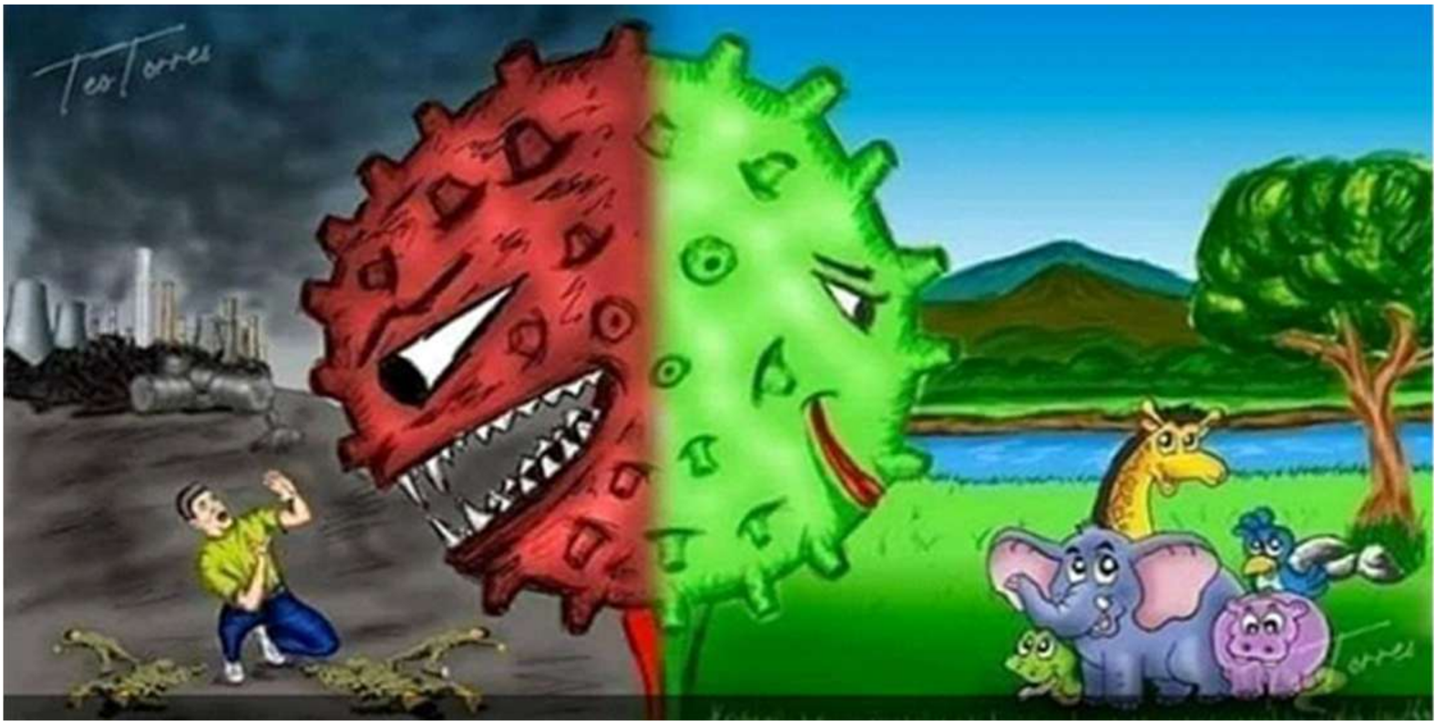
I'D RECOMMEND THIS PODCAST TO ANYONE WHO LIKES ACCUMULATING RANDOM BITS OF KNOWLEDGE FROM VARIOUS AREAS OF SCIENCE, ALTHOUGH YOU MIGHT BE INTERESTED IN A PARTICULAR FIELD.

Of course, Carroll is still a physicist, and he definitely doesn't lose sight of that. The physics geeks ought not to miss the episodes featuring Carlo Rovelli, Leonard Susskind and Kip Thorne among other outstanding physicists Off late, Carroll's own research has ventured into the philosophy and foundations of quantum theory and quantum gravity, and he explores these ideas in his riveting solo episodes. Besides physics, there are numerous illustrious academic guests, such as Steven Strogatz (mathematician) and Carl Zimmer (evolutionary biologist) among others.



I'd recommend this podcast to anyone who likes accumulating random bits of knowledge from various areas of science, although you might be interested in a particular field. There are very few good science podcasts, and in my opinion, Mindscape is undoubtedly the best of them.

This article is the winner of the first edition of CritiQ, the review competition organised by the Science Council.



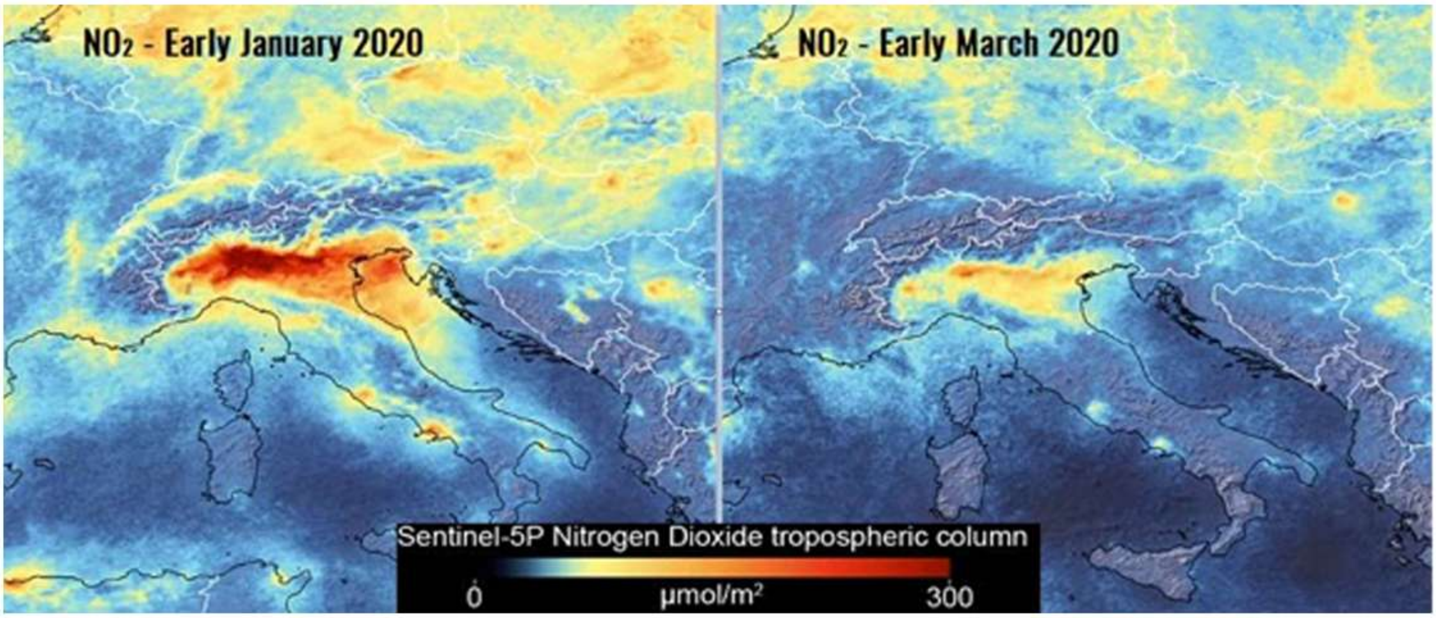
A *Silver* Lining

How the virus that is crippling mankind right now is proving to be a blessing in disguise for our downtrodden environment.

by Nayanika Mukherjee

2020 has so far been a rough year for humans all over the entire planet. There is widespread panic, fear, chaos and tragedy all around in the wake of the 2019 Coronavirus Disease pandemic, a.k.a. COVID-19. The virus outbreak has been deadly to mankind and to the global economy, and there is no downplaying its seriousness. However, as commonly spoken, every cloud has a silver lining. The COVID-19 pandemic has also, unexpectedly, had a positive environmental impact.

With more people staying at home due to nationwide lockdowns, the environment has benefitted immensely. Fewer vehicles on roads due to travel restrictions and the slowdown of businesses in an attempt to control the spread of the virus are the major reasons. There has been a sharp drop in carbon emissions across the globe due to less human activity.According to an article in BBC Future by Martha Henriques, levels of pollution in New York City have reduced by nearly 50% as a result of measures to contain the spread of the virus. In China, emissions fell by 25% at the start of the year. The proportion of days with “good quality air” was up by 11.4%.



compared to the same time last year in 337 cities across China, according to its Ministry of Ecology and Environment. In Europe as well, satellite images (below) show nitrogen dioxide (NO2) emissions fading away over northern Italy.

Images of clear water in the canals of Venice have started appearing on the internet, revealing the fish that live there. The steep decrease in tourist traffic has significantly improved the water quality.

However, the most prevalent question still stands: will this positive climate change last after the pandemic ends? We can foresee either one of two possibilities: People spending time at home, travelling only when necessary and cutting down on food waste might lead them to focus on these core priorities and adapt to this less demanding lifestyle even in the future, OR people may be waiting for the pandemic to end, in order to resume their travel and businesses, putting more pressure on the Earth than ever before. With the global economy declining, the latter seems to be much more reasonable and likely to occur, since as the economy recovers, global anthropogenic emissions will increase at a rate higher than before, eliminating and overruling the positive impacts on the environment presently caused by the coronavirus outbreak.

Although a positive change in climate at the cost of lives, jobs and mental health is not something anyone may want, this pandemic is, undoubtedly, a lesson for humans and communities on what changes could be brought about if they look out for each other and for the planet as a whole and live sustainably. It is indeed shameful that it takes a deadly virus to remind us of our unhealthy lifestyles, but since all’s well that ends well, we can still hope to try and adapt practices that are beneficial and favorable for both us and the environment.

Editor's Pick

The World at the Tip of a Needle

On a mission to make science even more memorable

by Bijoy Dey

What is the storage capacity of this device? This is a very frequent question we ask on seeing a new electronic device. Generally, the answer is in the range of 16-32 G.B. (Gigabyte) for mobiles and 1-2 T.B. (Terabyte) for laptops. The larger the storage capacity (memory) of the device is, the more data we can download (videos, songs, movies, etc.). So, let's focus on how memory works. Is it the way our brain works? Or is it something different?

If we consider a computer as a living being, then electricity is its blood and hardware are the organs. The hard drive is that part of the hardware (brain) where data (memory) is stored. The hard drive is coated with magnetic material which can get magnetized or demagnetized by the use of electricity. Whenever you store some data on your hard drive, then, you are sending a certain pattern of electricity which magnetizes a specific part of the hard drive. That data is saved in this region. This way, these electric signals form a unique pattern using the binary system. In this method of data encoding and decoding, two binary digits, 0 and 1 are used. 1 implies a magnetized domain and 0 implies a non-magnetized domain. This 0 or 1 is called a digit of information. Eight digits of this kind constitute one byte, 1024 bytes give a kilobyte and so on (chart 1). The key point for any material to work as a storage medium is that the material needs to be magnetically bi-stable, that is, it should attain two different magnetic states (either magnetized 1 or demagnetized 0), with the help of an external stimulus (electricity in the present case).

Unit	Abbreviation	Storage
Bit	b	Single 1 or 0 (binary)
Byte	B	8 bits
Kilobyte	KB	1024 bits
Megabyte	MB	1024 KB
Gigabyte	GB	1024 MB
Terabyte	TB	1024 GB
Petabyte	PB	1024 TB
Exabyte	EB	1024 PB

Table: **Units of digital signal storage capacity**

With the ever-increasing demand for data storage, an alternate storage mechanism of higher efficiency is highly anticipated. One drawback with this current material is that the magnetic domain which saves one digit of information consists of several millions of atoms. So, a huge number of atoms/digits are used here.

In our lab at IISER Bhopal, we are trying to address this problem by reducing these million atoms to a one-atom system. We are aiming to design one molecule which will be able to show two different magnetic states by the use of an external stimulus. Till now electricity has beenused as an external stimulus, but now, researchers are focusing on light as a stimulus because of its cost-effectiveness and eco-friendly nature. If we are able to design such a molecule and deposit iton the metal surface as the magnetic coating of a hard drive, then using a light source, we can read and write on the hard drive. When we want to write data, we can use a particular laser light which will magnetize certain molecules and the data will be stored. So, the presence of laser light then will be counted as a 1 and its absence will be counted as a 0 (Scheme 1). To remove data another wavelength of laser light can be used, which will demagnetize the magnetized region. Using one molecule as a digit instead of millions will bring about a revolution in data-storage science.

To achieve this target we have to consider two aspects, first, the molecule should have a permanent magnetic moment and secondly, the magnetic moment should be sensitive to external stimuli (preferably light). One molecule has a permanent magnetic dipole if it has unpaired electrons in it. Iron (Fe) is an abundant element on earth which has unpaired electrons and it shows a unique magnetic bi-stable property called spin crossover (SCO). SCO active molecules change their spin states (number of unpaired electrons) upon exposure to certain external stimuli such as heat, light, and pressure. This change in the spin state leads to a magnetic response whichcan be used to read/write the data. We are synthesizing several molecules with Iron showing SCO behavior where we can control the magnetic moment of the molecule with the help of external stimuli.

One such molecule is being published by our group (Inorg. Chem. 2019, 58, 1134−1146). In this molecule, we have

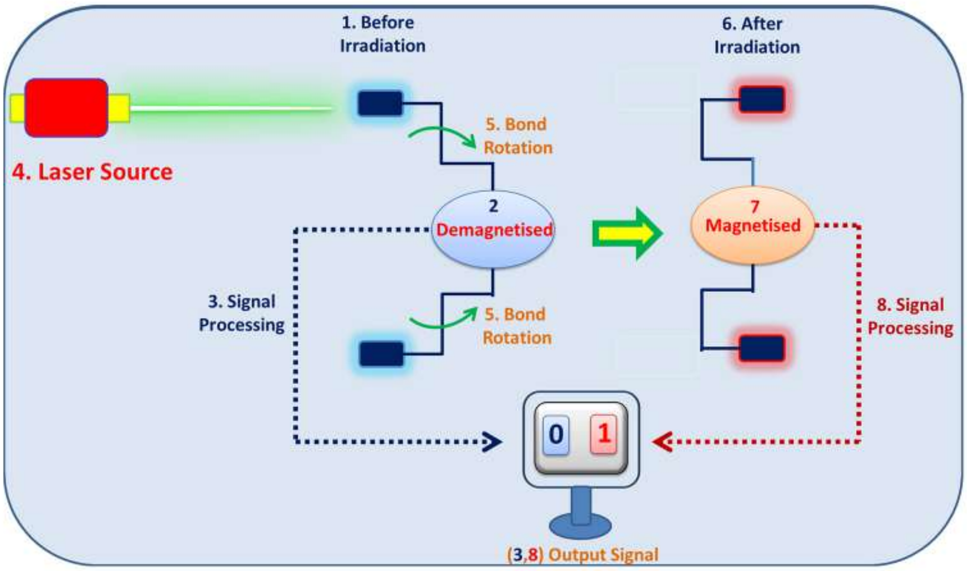


Figure: Schematic stepwise representation of the working principle of the molecule as a magnetic data storage material. 1. Before irradiation, 2. Molecule is demagnetized, 3. Demagnetized state registers a binary signal corresponding to 0, 4. Laser irradiation is used, 5. Conformation of the molecule changes, 6. After irradiation molecule is in a different conformer, 7. Molecule is magnetized/magnetic response of the molecule is 8. Different magnetic moment of the molecule registers another binary signal corresponding to 1

considered both the magnetic and optical aspects.

The molecule contains Fe(III) having five unpaired electrons and showing SCO behavior. For the optical method, we have used an azo-benzene based molecule which shows various conformations upon irradiation with ultraviolet (UV) light (Photo-switching behavior). So, we can alter the conformation of the molecule by using light, thus changing the magnetic response of the molecule. This change in the magnetic moment can be recorded as a signal to store data. To confirm this, we have taken UV-V is data for the complex with and without laser light irradiation and the result is astonishing. The conformation of the molecule has changed inthe liquid state confirming it's photo switching behaviour. Also from the thermogravimetric (weight loss or decomposition of the sample with respect to temperature) analysis, it is found that the complex is stable up to a high temperature (485 K) which makes it a good candidate for storing data even at higher temperatures. Till now, we are able to study such properties in the liquid state only. Now, we are modifying the system so that we can observe such effects in the solid-state also. The optimization is still going on to obtain the best molecule which will show a huge change in the magnetic moment on exposure to light. Then, we can deposit these molecules on a metal surface and use it for data storage applications. Just to comprehend the increase in data storage capability, the tip of a needle has more than one million million molecules. Now if, each molecule behaves as a digit, then, we will get 116 GB of data. This space is enough to accommodate more than 25K songs, 200 movies and millions of books. If we achieve this goal, the amount of space we shall get is extraordinary.Not only will it lead to an industrial revolution, but also a social one. So, it is a science mission with a scientific and social relevance.

.

The author is a fourth year Ph.D. student in the chemisrty department working in the Molecular Magnetism Lab under Dr. Sanjit Konar. His research focuses on magnetic bistable molecules.

Team
CHRYSALIS

EDITORIAL TEAM : Vyom Kulkarni
Krishna Prahlaadh R
Harsha Vardhan
Sarthak Mishra
Abhisek Swain
Nayanika Mukherjee
Mansi Bhati

DESIGNING TEAM : Hitaishi Desai
Agastya Singh

Indian Institute of Science Education and Research
Bhopal