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COVID-19: In Point View of Physics

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Abstract

Detailed Physics point view of COVID-19 studied in-depth, Size of the CORONA virus is nearly 120-125nm. During sneeze it produces thousands of droplets; the velocity of these droplets is nearly 20metre/second. During coughing produces 10-100 droplets moving with velocity 20metre/second. Hence we can prevent the flow of such droplets can be controlled by having a mask and keep social distancing.

Keywords: COVID-19, SARS-CoV-2, Physics, coronavirus

Introduction

Right now latest novel coronavirus, SARS-CoV-2, has reached pandemic status. While health workers and governments do their part, scientists are trying to understand the virus and develop vaccines and treatments. Citizens, We the people of India looking what next? During this situation, basic science community people are thinking how physics and mathematics plays an important role in the understanding and detailed study of this deadly virus.

Origin: If we take back the history of the origin of this pandemic is probably originated in one of the several species of horseshoe bat found throughout east and south-east Asia. Possibly, a pig or another animal ate the bat's droppings off a piece of fruit, before being sold at a wet market in Wuhan, China, and subsequently infecting one of the stallholders. Or maybe the first transmission to a human occurred elsewhere.

There is a lot we don't know about the novel coronavirus now called SARS-CoV-2 and its resultant disease, COVID-19. What we do know is that Chinese authorities alerted the World Health Organization (WHO) to the first known cases in Wuhan during Dec-2019. Less than a fortnight later, one of those infected people was dead. By the end of January, with more than 10,000 diagnosed and 200 fatalities in China alone, and with the virus cropping up far beyond the country's borders, the WHO declared a global emergency as Virus is pandemic.

Present Statistics

As of this article's publication (10th June 2020,), the WHO (1) report's that the virus has spread globally, with over 71,45,539 confirmed cases worldwide and the number of deaths exceeding 4,08,025. The status of "pandemic" was officially designated on 11 March 2020 and many countries have introduced social distancing, travel restrictions, lockdowns, hotspot creation, red zone creation and quarantine methods to curb the spread. Festivals, sports events, parades, marriages, fairs and conferences are being called off due to the front-line support services they require and the concern that large gatherings of people could help spread the virus.

Across	No of Peoples Diagnosed	No of Peoples diseased
Globally	74,45,539	4,08,025
India	2,96,575	8659
Karnataka	6161	72

The most common symptoms of COVID-19 are fever, dry cough, and tiredness. Other symptoms that are less common and may affect some patients include aches and pains, nasal congestion, headache, conjunctivitis, sore throat, diarrhea, loss of taste or smell or a rash on skin or discolouration of fingers or toes. These symptoms are usually mild and begin gradually. Some people become infected but only have very mild symptoms.

History : When it comes to viruses, there is good reason to worry about novelty. Throughout its history, humanity has had to contend with new diseases springing up seemingly out of nowhere, spreading like wildfire and leaving scores of dead in their wake. In ages past, bacterial plagues were often the source of that terror. Since the birth of modern medicine, however, novel viruses have assumed the mantle of doom. Take Spanish flu for example, which killed up to 100 million people a century ago, and then more recently, HIV, which has led to around 32 million deaths to date. It is only a matter of time before another devastating pandemic, and though epidemiologists do not know what type of virus it will be, they do know that it will be different from anything witnessed before.

Whether or not SARS-CoV-2 is the next "big one", there is something else epidemiologists are grimly aware of: today, disease travels fast. The Black Death that ravaged Europe, as well as parts of Asia and Africa, in the mid-14th century spread at an average of just 1.5 km a day – hardly surprising, since this was before ships could reliably cross oceans and the fastest mode of transport was by horse. Contrast that with the 2015 outbreak of Zika virus in South America, where the daily dispersion was on average 42 km, peaking in the densest-populated parts of Brazil at 634 km. Faced with more populous cities, more mobile people and more international travel, scientists must respond to the threat of viral pandemics faster than ever.

In Point View of Physics

Physics-based techniques play a huge role in the field of structural biology. The vast majority of biological macromolecule structures are obtained by X-ray crystallography, going back to 1934, when John Desmond Bernal and Dorothy Hodgkin (2) recorded the first X-ray diffraction pattern of a crystallized protein, the digestive enzyme pepsin. Their work stemmed from that of physicists such as Wilhelm Röntgen, who discovered X-rays; Max von Laue, who discovered that X-ray wavelengths are comparable with inter-atomic distances and are therefore diffracted by crystals; and William Henry and William Lawrence Bragg, who showed how to use a diffraction pattern to analyze the corresponding crystal structure. Hodgkin went on to win the 1964 Nobel Prize for Chemistry for her determinations by X-ray techniques of the structures of important biochemical substances.

Single biological molecules also diffract X-rays, but only very weakly. Crystallization, as Bernal and Hodgkin employed for pepsin, is helpful because it results in the repetition of huge numbers of molecules in an ordered, 3D lattice, so that all their tiny signals reinforce one another and become detectable by photographic plates in the early days and by active pixel detectors today. These signals are not images of the molecules, for there are no materials that can substantially refract, and thereby focus, scattered X-rays. Rather, the signals are merely the sum of the contributions of X-rays diffracted from different parts of the molecule. To pick apart these contributions, structural biologists rely on a mathematical tool – the Fourier transform. The calculated contributions are then equated with possible atomic structures by a lot of careful interpretation.

Of course, to obtain the signals in the first place requires X-rays. Nowadays, synchrotron radiation sources – large facilities that accelerate electrons in a continuous ring – are ideal for macromolecular crystallography because they produce high-intensity X-rays with a very narrow spread of wavelengths. At these machines, according to Wlodawer, diffraction datasets that would have taken months with X-rays from traditional rotating anode generators take just seconds to compile.

Technological developments such as these spurred the first into rational drug design, in which scientists study the structure and function of molecules in order to work out what drugs might bind to them – and in the case of viruses, prevent them from replicating. Antiviral drugs for HIV were an early success. When HIV protease was identified in 1985 as an essential enzyme and therefore a potential drug target in the virus's life cycle, it took four years for its first crystal structures to be determined, and a further six years for the first licensed drugs to inhibit it. "That's probably one of the best-documented cases of how quickly rational drug design can go," with the structural analysis of a virus using X-ray diffraction technique.

Today, it might have gone faster. The size of the Coronavirus can be estimated using TEM (Tunneling Electron Microscope), SEM (Scanning Electron Microscope) the size is nearly around 120-125nm.

The analysis of SARS-CoV-2 is a prime example of this type of modern pipeline in action. On 5 February this year, a little over a month after the Chinese authorities disclosed the existence of the new coronavirus, a research team led by ZiheRao and Haitao Yang at ShanghaiTech University in China uploaded the structure of the virus's main protease to the Protein Data Bank (DOI: 10.2210/pdb6lu7/pdb), having obtained the dataset using X-ray crystallography at the Shanghai Synchrotron Radiation Facility. The structure is already helping pharmaceutical companies to explore potential drugs, such those used to tackle HIV.

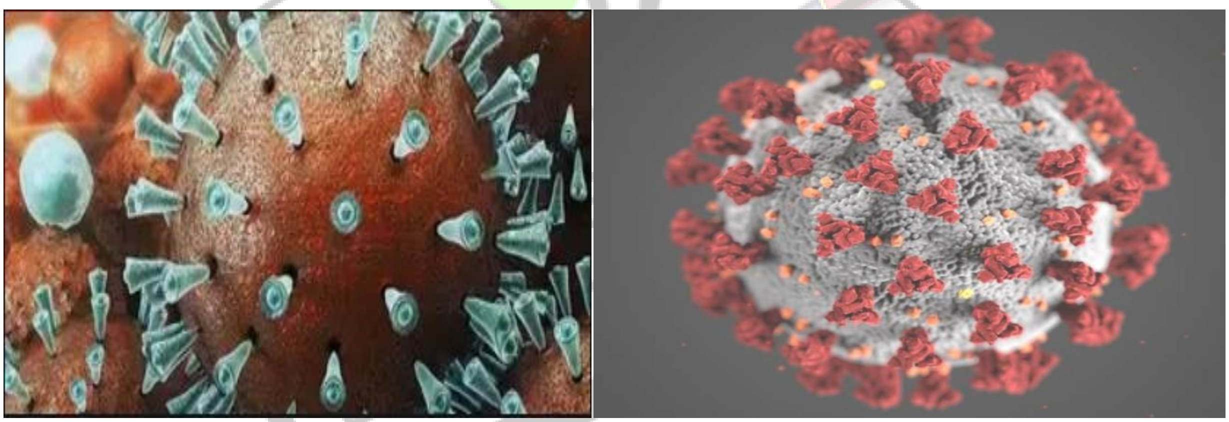

Fig : Sectional view of COVID-19 Virus in TEM image. Size is nearly 120-125nm.

The structure of the external spike is more useful for creating coronavirus vaccines than drugs. If host cells are exposed to virus-like particles that brandish the same external features, while being hollow inside, those cells can still help the body build an immunity but without the risk of being exposed to a dangerous, this virus is in a family of single-stranded "positive sense" RNA viruses that also includes polio and human rhinovirus – the latter being behind most cases of the common cold. "Only in the past few years have we been able to exploit structural biology to understand immunity to disease," he says. The knowledge of viral structures can even be used to design synthetic "therapeutic antibodies" to directly attack diseased cells.

Corona viruses are a large family of viruses which may cause illness in animals or humans. In humans, several corona viruses are known to cause respiratory infections ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). The most recently discovered corona virus causes corona virus disease COVID-19.

When physicists say that there is physics in everything, they mean literally everything, including how a disease is transmitted. From the generation of virus-laden respiratory droplets to dispersing in the air to inhalation or deposition on surfaces, a team from Johns Hopkins University(4) in the U.S tried to decode the flow physics of corona virus transmission. The paper published in the *Journal of Fluid Mechanics* notes that this can help us be better prepared to tackle disease outbreak in the future. The paper also lists preventive measures such as "use of face masks, hand washing, ventilation of indoor environments, and social distancing."

The fluid dynamic analyses helped to understand the mechanisms behind how the droplets are generated in the respiratory tract, and also characterize the density, size and velocity of ejected droplets. We also tried to estimate the settling distance, evaporation time and transport of the particles. They also looked at the effect of external factors such as air currents, temperature and humidity.

"This topic [fluid dynamics of respiratory diseases] has been studied before but only sparingly and we now find out with COVID-19 that there are significant gaps in our knowledge," Previous studies have shown that a single sneeze can generate thousands of droplets, with velocities above 20 metre per second, whereas coughing generates 10–100 times fewer droplets than sneezing with velocities of approximately 10 meters per second. Breathing and talking generate jet velocities less than 5 metres per second. Taking all this into consideration, this paper notes that this is why a three to six feet social distancing guideline is issued.

Summarizing airborne transmission, the paper notes that most of the droplets evaporate within a few seconds to form droplet nuclei — consisting of virions and solid residue of approximately 10 micrometres in size. These can remain suspended in the air for hours and given the approximately one-hour viability half-life of the SARS-CoV-2 virus these nuclei play an important role in the transmission. "The evaporation process...and the composition of droplet nuclei require further analysis because these have implications for the viability and potency of the virus that is transported by these nuclei,"

The final stage of airborne transmission is the inhalation of the virus-laden particles and its deposition in the respiratory mucosa. Face masks provide 'inward' protection by filtering these particles. Masks also provide 'outward' protection by trapping the virus-laden droplets expelled by an infected person.

Conclusion

The Physics point of view of the study of CORONA virus COVID-19 and its dynamics study reveals that the size of the virus is nearly around 125nm. The spread of the disease is in the form of droplets. It affects especially for respiratory organs. Hence use of masks, social distance, Sanitization is only keeping away from the disease.

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