Music of the spheres

Sun-like activity on the surface and within distant stars has fallen to observation, says s ananthanarayanan

SCIENTISTS at the National Center for Atmospheric Research in Boulder, Colorado, with colleagues in France and Spain, have monitored the seismic activity of a star 100 light years from the earth and have identified a magnetic cycle that is like the sunspot cycle of our own sun.

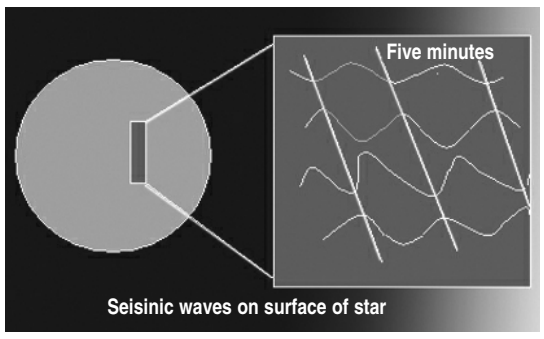
The sun and stars consist of an outer visible surface called the photosphere and an underlying core that is invisible. While sunspot activity is the appearance of dark spots on the bright disk of the sun, seismic activity in the core needs to be deduced from indirect data. This method of indirectly viewing the mechanical deformation of a distant star has shown correlation with star-spot activity in the same manner as observed on the sun. As the sun-star-spot action is related to magnetic flows, seismic observation promises to be a method of studying the magnetic behaviour of distant stars. This, in turn, is relevant to the habitability of planets of those stars.

Sunspots

Sunspots are areas on the sun's surface that temporarily get cooler than the surroundings because of the flow of heat getting blocked by magnetic forces. When places are cooler, they absorb more light than they radiate and, consequently, although they are themselves frightfully bright, they appear to be darker than their surroundings.

The intense magnetic activity in the vicinity of sunspots manifests as flares and coronas, or the flows, in loops and whorls, of huge quantities of ionised gases, the solar plasma. The sunspots themselves also expand and contract as they drift across the sun's surface. The larger ones can be many times the area of the earth and can be seen even without a telescope (by throwing an image on a screen or with a filter, never directly).

Sunspot population is known to follow an 11-year cycle, which also corresponds to the (minute) variation in the intensity of radiation coming in from the sun. The real nature of sunspots is still being studied and it is generally understood as the manifestation of intense magnetic fields temporarily forming in the stormy activity of charged ions in violent motion below the photosphere. The increase in the number of sunspots would thus reflect increased magnetic activity at the surface and although the spots are "cooler" islands, the surrounding areas get hotter than before and the total radiation from the sun begins to peak.

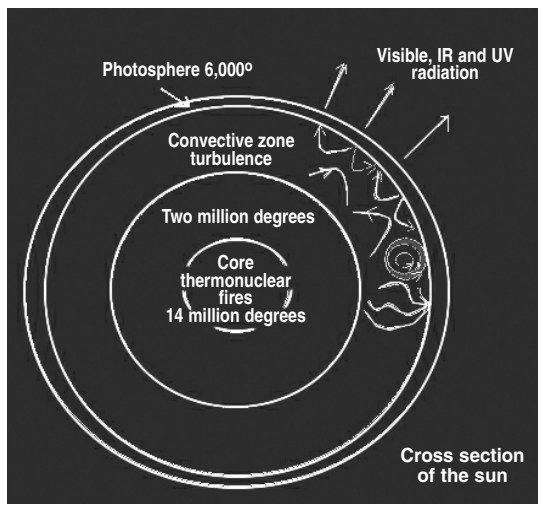


Seismology

In 1992, it was noticed that the exact colour of the spectral lines of light from regions of the sun seemed to slightly vary in a cycle of about five minutes. The only way to explain this was that the part of the sun was moving backwards and forwards every five minutes. When the surface was moving out, the colour shifted to the blue end and when the surface moved in, the colour shifted to the red end. Just like the whistle of an approaching railway engine is shrill, but turns to lower pitch as the engine passes and starts moving away.

More detailed observation showed that alternate areas moved in or out, as if there was a wave passing over the sun's surface. Millions of observations have now been recorded and there is a detailed list of different waves and periodic disturbances on the surface of the sun, reflecting continuous, back and forth, round and round and more complicated shock disturbances, like earthquakes, shaking the mass of the sun.

These observations, when compared to the seismic waves that affect the earth, help make conjectures about the interior of the sun. Interestingly, it is found that the seismic activity also corresponds to the magnetic activity of the sun.



Probing stars

The NCAR scientists were able to similarly measure seismic activity in a star in the constellation Unicorn, just east of Orion, with the help of data from *Corot* (*Co*nvection, *ro*tation and planetary *t*ransits), the orbiting telescope of CNES, the French space research agency. *Corot*, being in orbit and outside the atmosphere, is able to make high resolution measurements on stars and do this continuously, not only for part of the day, like terrestrial telescopes.

The data from *Corot* has helped the scientists identify areas of intense activity that corresponded to areas of intense magnetic activity, the *starspots*, the stellar equivalent of sunspots. Starspots and cycles of magnetic activity have been discovered in other stars, but this is the first time it has been found with the help of watching for seismic activity on the star.

"Essentially, the star is ringing like a bell," said Travis Metcalfe, co-author of the paper published in the journal *Science*. "As it move though the starspot cycle, the tone and volume of the ringing changes… moving to higher tones with lower volume at the peak of its magnetic cycle."

"The magnetic activity cycle in this star is like what we have seen with the sun," says co-author Savita Mathur. "This technique of listening to stars will allow us to examine potentially hundreds of stars."

Understanding the magnetic activity of stars will help assess the magnetic forces acting on planets and hence the possibility of the planet harbouring life. The understanding will also sharpen our knowledge of magnetic activity of the sun, which routinely affects power grids and communication networks on earth.

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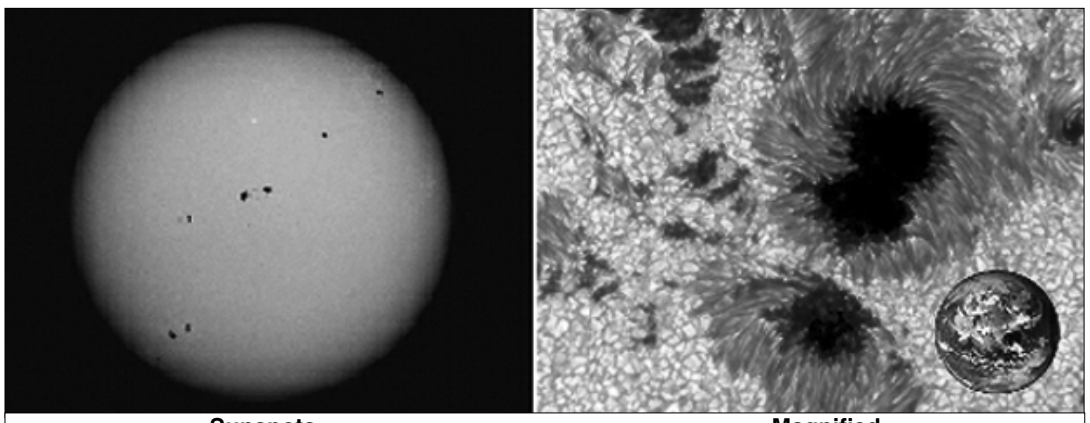


On the road to creating a 'smarter planet'

The world will continue to become smaller, flatter… and smarter, writes puneet gupta**. And Information Technology is vital for improving our lives and seizing the future**

INFORMATION Technology does matter… and a lot at that, if only because IT is harnessed not just for technology's sake but for adding meaningful value to business, society and the planet. As technologies, markets and social conventions have evolved over years, it is critical to calibrate new approaches for stimulating innovation, enriching lives, building smarter cities and making the world a better place. How do we achieve that? How do we make our lives better? How do we make our cities smarter? What must we do to improve? We won't find the answers if we treat these as rhetorical questions and relegate them to think tanks and ivory towers.

Let's consider cities. Homes to more than half the world's population, they can be seen as complex networks of components: citizens, businesses, transport, communications, water, energy, city services and other systems. Citizens and businesses rely on infrastructure systems for their activities and wellbeing. Improvements – or disruptions – in transportation, communications and utility systems can have a dramatic impact on the daily activities of citizens and businesses. City services integrate and coordinate the activities taking place in the other components. Understanding how cities improve and change through the lens of these elements offers cities new perspectives on the progress they are making toward achieving strategies and objectives.

Cities continue to develop and refine their economic and social goals and the strategies to achieve these. The performance of core systems of today's cities is fundamental to social and economic progress. A new generation of solutions that capitalises on instrumented, interconnected and intelligent capabilities can be applied against virtually any of a city's core systems. Faced with major challenges, these systems can be improved and optimised through the application of smart IT solutions.

Instrumentation enables cities to gather more high-quality data in a timely fashion than ever before. For example, utility meters and sensors that monitor the capacity of the power generation network can be used to continually gather data on supply and demand of electricity. The pervasiveness and low cost of existing devices and sensors, like gas, electricity and water meters, offer the ability to measure, sense and understand the exact condition of virtually anything. Add to that new sensors and devices that offer further data gathering possibilities, such as Radio-frequency identification (RFID) tags. These existing and new sensors and devices can now be embedded across key city systems as a first step in addressing and solving many of the challenges cities face, ranging from improving library services to maintaining sewerage systems.

Besides, interconnection creates links among data, systems and people in ways not previously possible. For example, billions of people will use the Internet. Soon, the world will be populated by more than a trillion connected and intelligent things, such as cars, appliances, cameras, roadways and pipelines, collectively creating an "Internet of things". These interconnections enable communication and coordination among objects, people and systems across the city framework, opening up new ways to gather and share information.

Also, intelligence in the form of new kinds of computing models and new algorithms enables cities to generate predictive insights for informed decision making and action. Combined with advanced analytics and ever-increasing storage and computing power, these new models can turn the mountains of data generated into intelligence to create insight as a basis for action. For example, statistical models with time-dependent data feeds to predict traffic flows can be used to adjust and optimise congestion pricing according to need.

A new generation of solutions that capitalises on instrumented, interconnected and intelligent capabilities is emerging and can be applied against virtually any of a city's core systems. Further, they can help illuminate the interactions among different systems, giving leaders a better understanding of what's happening in their cities and allowing for more effective action as a result. For instance, IBM is installing a smart grid at Malta — a group of islands in the Mediterranean sea — which will integrate both water and power systems and be able to identify water leaks and electricity losses in the grid. IBM is intent on using IT to create many such "smart grids" all over the world, including India, in a bid to create a "smarter planet". The reason is simple: every minute during the next 20 years, 30 Indians will leave rural India for urban areas. India will need some 500 new cities, and if they are smarter, the better for us.

Indeed, cities around the world are becoming smarter. For example, intelligent traffic systems adjust the lights and signals in real time, controlling the speed of traffic and directing the flow to less-congested routes. Sensor technologies, GPS and satellites can provide drivers with information to help them choose the best routes during peak travel times. Stockholm has already reduced peak hour traffic by 20 per cent. The predictive traffic system in Singapore is nearly 90 per cent accurate.

To take advantage of how smarter city approaches can help advance those strategies, city authorities and stakeholders need to understand how their city is performing today and where progress is being achieved in infusing intelligence into their systems. This calls for a systematic assessment of a city's position in relation to its peers. Such an assessment can identify and help communicate emerging strengths and weaknesses. Indeed, it can highlight where real progress is occurring and inform a plan for future improvements and help cities prioritise actions.

However, that progress can only come if successes also occur simultaneously on all of the four fronts: political, economic, social and technological, not just along one dimension. National and regional governments have a central, indeed crucial, role to play in leading their citizens and institutions through economic development. The only way to achieve this and thrive in today's increasingly challenging environment is by innovating — in technologies, in strategies and in business models.

Today, what matters most is the value that arises from a creation and not just technology for its sake. There is an intense need to "think collaboratively" and in a multifaceted manner. There is a growing hunger for fundamentally new approaches. The world will continue to become smaller, flatter… and smarter. We are moving into the age of the globally integrated and intelligent economy, society and planet. And, IT is vital for making our lives better, and seizing the future.

The writer is vice-president, Public Sector, IBM India and South Asia

Wearing thin

Over the years, the ability of bacteria to develop resistance and to pass it to other strains has progressed dramatically, says tapan kumar maitra**. Which is why physicians shouldn't over-prescribe antibiotics both to humans and farm animals**

ANTIBIOTICS — substances living organisms produce that are toxic to other living organisms — are significant for two basic reasons: they are extremely important in fighting diseases that afflict humans and farm animals and many of them are useful tools for analysing protein synthesis.

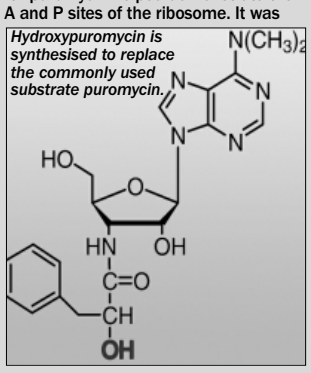
Some antibiotics impede the process of protein synthesis in a variety of ways, often poisoning bacteria selectively; the effectiveness of antibiotics normally derives from the metabolic differences between prokaryotes and eukaryotes. For example, an antibiotic that blocks a 70S bacterial ribosome without affecting an 80S human ribosome could be an excellent one. About 160 antibiotics have been discovered till date.

Puromycin

Puromycin resembles the 3' end of an aminoacyl-tRNA. It is bound to the A site of the bacterial ribosome where peptidyl transferase creates a bond from the nascent peptide attached to the transfer RNA in the P site to puromycin. Elongation can then no longer occur. The peptide chain is released prematurely and protein synthesis at the ribosome terminates.

Experiments with puromycin helped demonstrate the existence of the A and P sites of the ribosome. It was found that puromycin could not bind to the ribosome if translocation factor EF-G were absent. With EF-G, translocation took place and puromycin could then bind to the ribosome. Its ability to bind only after translocation indicates that a second site on the ribosome becomes available after translocation.

Hydroxypuromycin is synthesised to replace the commonly used substrate puromycin.



Streptomycin, tetracycline & chloramphenicol

Streptomycin, which binds to one of the proteins (protein S12) of the 30S subunit of the prokaryotic ribosome, inhibits initiation of protein synthesis. Streptomycin also causes misreading of codons if chain initiation has already begun, presumably by altering the conformation of the ribosome so that transfer RNAs are less firmly bound to it. Bacterial mutants that are streptomycin-resistant, as well as mutants that are streptomycin-dependent (they cannot survive without the antibiotic), occur. Both types of mutants have altered 30S subunits, specifically changed in protein S12.

Tetracycline blocks protein synthesis by preventing an aminoacyl-tRNA from binding to the A site on the ribosome.

Chloramphenicol blocks protein synthesis by binding to the 50S subunit of the prokaryotic ribosome where it blocks the peptidyl transfer reaction. Chloramphenicol does not affect the eukaryotic ribosome. However, chloramphenicol as well as several other antibiotics is used cautiously because the mitochondrial ribosomes within eukaryotic cells are very similar to prokaryotic ribosomes.

Some of the antibiotics that affect prokaryotic ribosomes also affect mitochondria. As recent research has substantiated, the similarity between bacteria and mitochondria implies that the latter has a prokaryotic origin. (Similarities between cyanobacteria and chloroplasts also support the idea that chloroplasts have a prokaryotic origin.)

Over the years, antibiotics have virtually eliminated certain diseases from the industrialised world. They have also made modern surgery possible by preventing serious infections that tend to follow surgery. Antibiotics have been so successful that, in the 1980s, many pharmaceutical companies drastically cut back the development of new antibiotics. However, a disaster is in the making, as physicians over-prescribe antibiotics to people and farm animals: bacteria are not prepared to take this onslaught without fighting back.

Mutation takes place all the time at a low but dependable rate. Thus, resistant bacteria are constantly arising from sensitive strains. We can select for penicillin- and streptomycin-resistant strains of bacteria in the laboratory by allowing the antibiotic to act as a selective agent, removing all but the resistant individuals. The same sort of artificial selection that we can apply in the lab applies every time a person or animal takes an antibiotic. We have surely reached that point where the ability of bacteria to develop resistance and to pass that resistance to other strains has developed dramatically and this calls for caution.

The process of evolution works amazingly fast in bacteria because of their ubiquity, large population sizes and the ability to transfer genetic material between individuals. We may shortly find ourselves as we were before World War II when even simple infections in hospitals turned lethal. As of now, only one antibiotic can keep the common and potentially deadly infectious bacterium staphylococcus under control — vancomycin. But several types of disease-causing bacteria have already evolved a tolerance to vancomycin.

The answer to this potentially disastrous problem is to develop new antibiotics and reduce the irresponsible use of antibiotics in people and animals. Hopefully, the warning bell has been sounded. Pharmaceutical companies are developing at least a dozen new antibiotics to counter lethal bacteria.

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