Colloid choreography

Rhythm and tempo can affect the dance form in physical systems too, says s ananthanarayanan

MATERIALS form when atoms or molecules align themselves along the most stable patterns. Of course, there could be an alternate form, like carbon atoms are stable in the form of diamond as well as that of graphite. Various conditions at the time of deposition of the material determine what form the component particles choose. But when the particles themselves are moving, and rotating, and affecting each other, there could be more stable states, and ways of controlling the state, or a switch from one state to another.

Jing Yan, Moses Bloom, Sung Chul Bae, Erik Luijten and Steve Granick, all working in institutes in Illinois, USA, report in the journal *Nature* their discoveries with micron size particles that spin and rock independently in a magnetic field and form themselves into smaller and larger groups due to mutual interaction. The work is seen as opening the door to innovative methods of forming new materials and also to illuminate the working of biological processes.

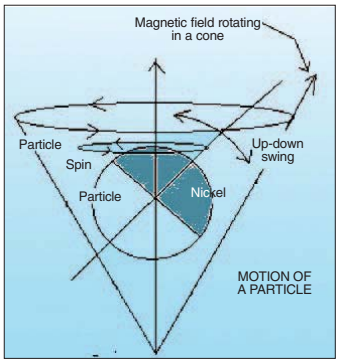
An element of the static can be introduced into things in motion if there is a pattern in their mutual orientation. This is like independent dancers who follow the same rhythm and face each other, or the other way, in a repeating sequence. Physical systems in periodic motion usually fall into step with each other if they are allowed to interact. An example would be a pair of pendulum clocks that are placed on the same shelf or suspended from the same framework.

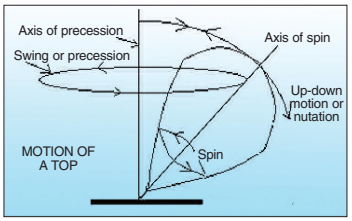
Typically, the stage of swing of one pendulum, or its *phase*, would not be the same as that of the other pendulum. But given some time, the movement of each pendulum affects the other, and they speed up or slow down and slip into synchronised swing, in opposite phase, each exactly balancing the other. This is the effect, for instance, that is used to keep a quartz watch ticking at the precise frequency of the crystal, or in the working of lasers or even the way the applause in a auditorium slips into regular, rhythmic clapping.

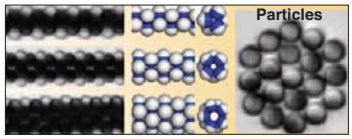
The Illinois group used a system of interacting particles that were not only driven by the same periodic frequency but could also move about and position themselves for greater or lesser interaction with each other. They found that stable formations that resulted depended on the frequency of the periodic motion, changing from tubes to chains of sheets, all consisting of rotating, swinging and interacting particles, as conditions were varied.

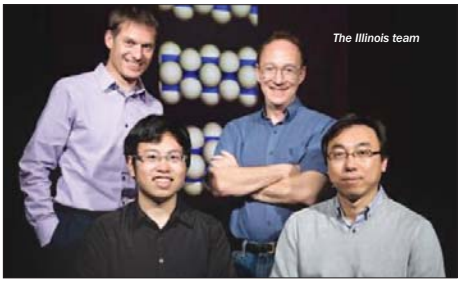
The particles used were spheres of silica, or ordinary sand, just three microns in diameter. The spheres were coated on one side by a film of nickel, which made that side magnetic. Because of this feature of having two different faces, the particles are called *Janus particles*, after the Roman god who had a face on either side of his head.

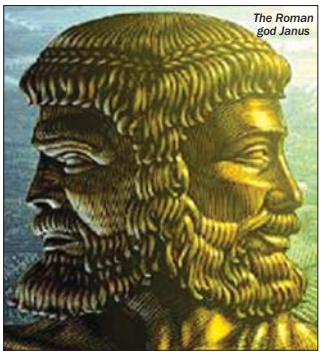
These one-side coated spheres were then suspended as a colloidal solution in water, where the particles were free to turn around or move, when acted upon by forces. Now, if a magnetic field that was swinging round and round, in the shape of a cone, was applied to the particles, the field affected the side that was magnetic and set the axis of the particles turning round with the speed of the magnetic field. As it was now a case of magnetic particles spinning in a magnetic field, the particles behaved like a top spinning in the earth's gravity. The axis of rotation of the particles thus also swung up and down, apart from round and round. The angle at which the axis of the particles rotated and also the angle through which the axis swung depended on the angle of the cone of rotation, and the speed of rotation of the applied magnetic field.








The Illinois team


The Roman god Janus

So far, what we have is each particle set into motion by the magnetic field and doing its thing at the stage that depends on how it started — which means that each particle is at a different stage of the rotation, or phase of the periodic movement. But because the particles are themselves magnetic, they affect each other and, like the two clocks on the shelf, they would push and pull the phase of each other till they fell into synchronisation. But unlike the clocks on the shelf, these particles suspended in water were able to move and adjust position. The push and pull of other particles thus nudged not only their phase of periodic motion but also their position till they fell into a stable orientation, which was, in fact, the condition of least energy. Once formed into these orientations, the bulk patterns also began to rotate while the formations were stacked head to tail, because each group had magnetic orientation.

When the applied magnetic field was swinging in a narrow cone, it was seen that the particles formed micro-tubes of stacked groups of particles. The tubes started out as just zig-zag chains, which formed into closed shapes, which stacked as short strands of the tube form to soon form into the long and regular tube structures that settled to the bottom of the vessel and rolled about, as a unit structure. Increasing the cone angle of the applied magnetic field led to the formation of closed shapes with sides of a smaller number till there were no closed shapes but only zig-zag chains. When the greater cone angle was further enlarged, the pattern was of sheets of six-sided motifs.

Dynamic structures

That particles can form themselves into stable shapes and structures is well known and is the basic of much of material science. But the difference in the structures of the Illinois group is that the units in the structure are all in motion and locked in relative orientation, like the tidal forces that keep the moon always showing the same face to earth, as it goes around in the month-long orbit. The existence of such motion of the component particles introduces changes in the orientation of the structure according to the principles contained in the dynamics of the motion of a top or of the planets and moons in a solar system.

Under these conditions, it was seen that changes in the angle of the cone or features that affect the magnetisation or mobility of the particles allows changes from one stable configuration to another, of a kind that is not possible in the case of static formation of structures by particles. The design of materials uses principles of stability that comes from a condition that has minimum energy. For this purpose, the sensitive scanning of different structures with dynamic modelling can facilitate the self-assembly of building blocks for industrial materials. The tube structures that arise from *Janus* particles could also be used for the transport of selected materials and understanding of such mechanisms in biological processes.

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Waste to wealth

Pomegranate peel can be used to make gold and silver nanoparticles, writes biplab das

A STUDY shows that discarded pomegranate peel can be used to synthesise nanoparticles of gold and silver. These are ultra-small particles, ranging from 1-100 nanometres (a nanometre is a billionth of a metre) and find extensive use in biomedical and electronic devices.

Most processes for the synthesis of nanoparticles are complex and involve harmful chemicals. A joint research team from Patna University and Magadh University in Bihar and Aveiro University in Portugal has developed this eco-friendly method that does not even require heating.

Certain plant-based processes have been developed for synthesising gold and silver nanoparticles in the past but no previous study has ever explored the potential of food waste such as discarded pomegranate peel for the purpose. The findings of the study have been published in the November 2012 issue of *Advanced Materials Letters*.


Illustration: VAIBHAV RAGHUNANDAN

Fruit peel extracts are rich in chemical compounds like alkaloids and poly-phenols. The researchers found that ellagic acid — a phenol found in fruits – could stabilise silver and gold nanoparticles in water. For the experiment, they added washed, fresh pomegranate peel to ultrapure water and boiled it for 15 minutes. The solution was filtered to obtain pure extract. They observed that when this extract was added to silver nitrate, the solution turned yellowish-brown in an hour, indicating the formation of silver nanoparticles.

When the extract was added to chloroauric acid, the solution formed gold nanoparticles and turned pink-red in colour after an hour. Both types of nanoparticles were spherical in shape. Silver ones were five nanometres in size and gold ones were 10 nanometres.

"Stable nanoparticles were formed within an hour of the reaction. This is one of the fastest ecological methods to produce silver and gold nanostructures using food waste," said lead researcher Seema Sharma of the Anugarh Narayan College of Magadh University in Bodh Gaya.

CSE/Down To Earth Feature Service

No Ferrari, just a new banana

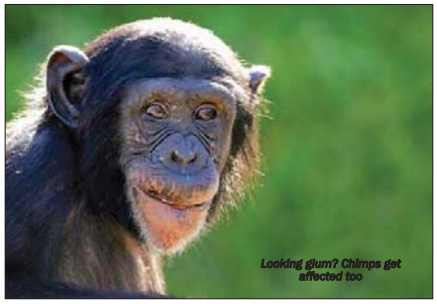
steve connor **reports on a study that shows chimpanzees and orang-utans share the same emotional slump in middle age as humans**

THE puzzle over why most people experience a mid-life crisis could be nearer to a solution following a study showing that chimpanzees and orang-utans share the same emotional slump in middle age. Scientists have discovered that captive apes in zoos around the world suffer a similar mid-life dip in happiness and wellbeing that is widely experienced in men and women from different socio-economic groups.

The findings suggest that the mid-life crisis in humans, which has until now defied a rational and plausible explanation, could be due to an underlying biological phenomenon that we share with our closest living relatives — the apes. The study, carried out on 508 chimps and orang-utans in zoos around the world, revealed that ape "happiness", as measured by a rigorous set of criteria monitored by their keepers, follows the same distinctive U-shape curve seen in humans.

Young apes start out happy but as they grow older they suffer a gradual emotional descent into a depression-like slump before going through an increase in happiness again during the final few years of life, the study found.

Professor Andrew Oswald of Warwick University, who has been studying human happiness for 20 years, said the findings indicated a fundamental biological basis for the mid-life crisis in people, which he said had little to do with the economic trappings of middle age. "We hoped to understand a famous scientific puzzle: why does human happiness follow an approximate U-shape through life? We ended up showing that it could not be because of mortgages, marital breakup, mobile phones or any of the other paraphernalia of modern life. Apes also have a pronounced mid-life low, and they have none of those," he said.


Looking glum? Chimps get affected too

The apes in the study lived in zoos in the USA, Japan, Canada, Australia and Singapore. Their keepers were asked to fill in a standard questionnaire on ape behaviour that is widely accepted as a good measure of primate wellbeing, said the study published in the journal *Proceedings of the National Academy of Sciences*.

For both species and in all parts of the world where they lived, the results indicated a clear dip in wellbeing in mid-life, which turned out to be a near-perfect match for what also happens in humans. "Our results imply that human wellbeing's curved shape is not uniquely human and that, although it may be partly explained by aspects of human life and society, its origins may lie partly in the biology we share with great apes," the study said.

Professor Oswald said that changes in human physiology with age, such as hormonal changes, may contribute to the mid-life crisis, although the menopause in women has been ruled out as a cause.

Previous theories to explain the ubiquity of human mid-life crises centred on the financial hardships of middle age, a rise in regret for lost opportunities, or a realisation that certain aspirations of life are in reality unattainable, the study said.

Professor Oswald said that the lack of data to support any of these theories led him to approach primatologist Alexander Weiss of the University of Edinburgh to see if there were any parallels in the animal kingdom. "Based on all of the other behavioural and developmental similarities between humans, chimpanzees and orang-utans, we predicted that there would be similarities when looking at happiness over the lifespan, too," Dr Weiss said. "However, one never knows how these things will turn out, so it's wonderful when they are consistent with findings from so many other areas."

The Independent, London

Growing old disgracefully

THE stars who suffered include:

■ **Charlie Sheen: had a very public meltdown in March 2011, saying, "I'm not bipolar, I'm bi-winning," in an interview on ABC's *Good Morning America*. Sheen then told the *Today Show's* Jeff Rossen that he had "tiger blood".**

■ **George Michael: the troubled singer hit a new low when he crashed his Range Rover into a Hampstead Snappy Snaps store in 2010. The former Wham! star had only just completed a two-year driving ban for a previous offence.**

■ **Mel Gibson: the *Braveheart* star blamed his drunken, anti-Semitic rant in 2006 on a "moment of insanity". The incident was one of many drink-related blunders he made that year, leading him to seek help for alcoholism.**

■ **Hugh Grant: after becoming a father for the first time last year, the *Notting Hill* star said he went through a period when he was scared of ending up "alone in front of the Christmas tree". He clung on to his youth by going to bed with his iPad.**