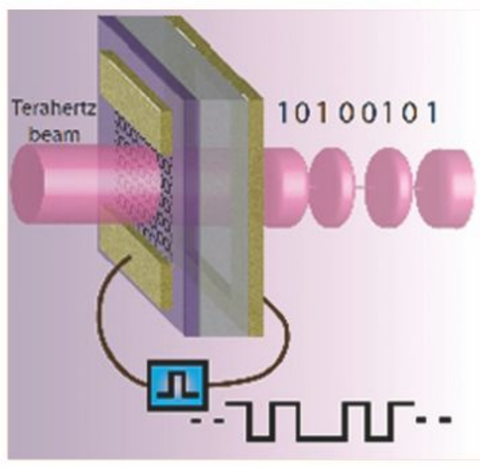
New era in communication science

ALTHOUGH all electromagnetic waves travel at the speed of light, or approximately 186,282 miles per second, the length and frequency of the wave determines its ultimate use. The longest waves, also known as radio waves, can travel far distances making them perfect for transmitting data to televisions, radios and cell phones. The next region of the spectrum is microwaves. These smaller waves carry information to satellites and weather radars, as well as impart energy via microwave ovens. The remaining electromagnetic spectrum consists of terahertz, infrared, visible and ultraviolet radiation as well as x-rays and gamma rays. As with radio and microwaves, these regions are continuously explored and researched for new device applications.



Artistic rendering of a graphene-based device that modulates terahertz electromagnetic waves into low and high intensity, thus representing information transmission.

Until recently, the THz frequency range located between the far infrared and the high frequency microwave bands was one of the least exploited regions of the electromagnetic spectrum. With the ability to carry more information than its neighboring radio and microwave frequencies, THz waves have shown great potential for applications in healthcare screening, chemical sensing, object detection and high-speed wireless communications. However, most THz sources and devices used today are bulky and expensive, which limits their application and availability. The development of cheap, compact and efficient THz materials and devices would expand if not catalyze research on this region of the spectrum. The recent development of a new naturally-occurring and artificially-engineered material is closing this so-called "THz gap."

A research group led by Huili (Grace) Xing at the University of Notre Dame, with support from the National Science Foundation, has been actively developing graphene-based devices capable of efficiently manipulating THz waves. Graphene, an atom-thick sheet of bonded carbon atoms, can modulate or vary the properties of THz waves making it an ideal choice for THz-based devices and systems. "Graphene is a miracle material for THz applications," says Xing. "This is owing to its two-dimensional nature, which leads to extraordinary electrical and optical properties, and ease of fabrication, which leads to unprecedented degrees of freedom in terms of device and system design."

Xing, her colleagues and students at the University of Notre Dame aim to develop cheap, compact and high-performance graphene-based THz systems such as cameras and high speed communication chips. "Understanding the interaction of graphene with THz waves is the key for developing these THz devices," Xing says. Her group relies on numerical simulations and theoretical calculations to engineer their devices before fabricating them in the laboratory.

The graphene-based THz devices proposed and developed by the group so far consist of a layer of graphene and another two-dimensional layer of electrons separated by a thin insulator. The graphene layer affects the properties of the waves passing through the material, while the insulating layer serves to create a nonconductive space between the graphene and second electron layer. By applying a voltage between these layers, the absorption of THz waves can be tuned from close to zero to almost 100 percent. "It is amazing that we can observe such a strong THz response, considering that graphene is an atom-thick material," says Berardi Sensale-Rodriguez, a graduate student in Xing's group. "This is a result of the high electrical conductivity achievable in graphene, together with the possibility of constructing device structures where the electric field is enhanced in the graphene layers," explains Xing.

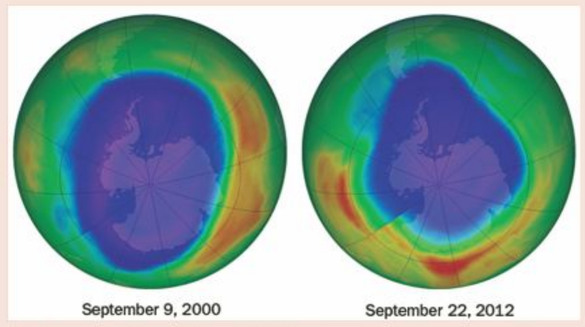
In a recent article published about their work ("Broadband graphene terahertz modulators enabled by intraband transitions", Nature Communications, 2012), the group reported their development of an intrinsically broadband THz modulator based on graphene sheets. In other words, a device capable of modulating THz waves in a wide range of frequencies. This modulator revealed more than double the THz manipulation of prior broadband intensity modulators. It is also the first demonstration of a graphene-based device enabled solely by intraband transitions. By adjusting the layers or transitions within the graphene material, THz waves can be tuned and manipulated. Such efficient THz modulation can result in unprecedented performance when applied to devices.

This novel application of graphene paves the way for the development of compact, cost-effective and highly efficient THz devices based on graphene and related materials. In the near future, these materials and devices may provide our everyday lives with such advances as improved communication systems and safer, more highly defined medical imaging.

Source: **Live Science**

FILLING IN?

Ozone hole shrinks



On September 22 (right), the hole in the ozone layer (blue and purple) above Antarctica reached its smallest maximum size in two decades.

THERE'S good news from Antarctica this fall: The seasonal hole in the ozone layer above the continent reached its smallest maximum extent and second smallest average in 20 years thanks to warm air temperatures.

Each September and October the ozone layer, which shields Earth from ultraviolet radiation from the sun, thins over the South Pole. On September 22, the ozone hole grew to its biggest seasonal size: 21.2 million square kilometers, an area slightly smaller than North America. That's the smallest the ozone hole has been at its annual maximum since 1990. Satellite and ground-based measurements collected by NASA and the National Oceanic and Atmospheric Administration put the average size of the 2012 ozone hole at 17.7 million square kilometers, the smallest average since 2002.

Reactions with chlorine from human-made chlorofluorocarbon gas are largely responsible for destroying the ozone layer. Frigid temperatures help promote this destruction. But natural weather fluctuations led to warmer Antarctic temperatures this year, which limited the damage, NASA and NOAA scientists say.

Source: **Science News**

POST-QUAKERISKS

Predicting aftershock

Earthquake off the coast of Sumatra, increased the number of worldwide earthquakes.

THE need to speed up work on a reliable system for predicting potential aftershocks in the days following a strong earthquake has become more urgent, say US scientists, after a rare quake earlier this year was found to have triggered many large, and potentially damaging, earthquakes around the world.

Writing in Nature last month (26 September), researchers said that the magnitude 8.6 earthquake that struck off the coast of Sumatra, Indonesia, on 11 April this year unleashed an unprecedented number of large events as far away as Japan and Mexico.

"The number of earthquakes worldwide of more than [magnitude 5.5] increased by a factor of five over a six-day period," Roland Burgmann, a professor in the Department of Earth and Planetary Science at the University of California, United States, and one of the authors of the report, told SciDev.Net.

"No other recorded earthquake has triggered as many large aftershocks around the world. We believe this was because it was the largest 'strike-slip' earthquake (where the two sides of a fault slip horizontally past each other) ever recorded, involving horizontal motions.

"Seismic waves from this type [of earthquake] are particularly strong and last long enough to affect distant fault zones," he said.

Last April's quake followed 6¬12 days of exceptionally low global seismicity, which coupled with the strength and duration of the shaking related to the strike-slip geometry of the fault may have been behind the large jump in global seismicity.

Source: **Sci.Dev.Net**

Perils of thawing Pole

AS much as 44 billion tons of nitrogen and 850 billion tons of carbon stored in arctic permafrost, or frozen ground, could be released into the environment as the region begins to thaw over the next century as a result of a warmer planet, according to a new study led by the U.S. Geological Survey. This nitrogen and carbon are likely to impact ecosystems, the atmosphere, and water resources including rivers and lakes. For context, this is roughly the amount of carbon stored in the atmosphere today.

The release of carbon and nitrogen in permafrost could exacerbate the warming phenomenon and will impact water systems on land and offshore according to USGS scientists and their domestic and international collaborators. The previously unpublished nitrogen figure is useful for scientists who are making climate predictions with computer climate models, while the carbon estimate is consistent and gives more credence to other scientific studies with similar carbon estimates.

"This study quantifies the impact on Earth's two most important chemical cycles, carbon and nitrogen, from thawing of permafrost under future climate warming scenarios," said USGS Director Marcia McNutt. "While the permafrost of the polar latitudes may seem distant and disconnected from the daily activities of most of us, its potential to alter the planet's habitability when destabilized is very real."

A new study finds that as much as 44 billion tons of nitrogen and 850 billion tons of carbon stored in Arctic permafrost, or frozen ground, could be released into the environment as the region begins to thaw over the next century as a result of a warmer planet.

To generate the estimates, scientists studied how permafrost-affected soils, known as Gelisols, thaw under various climate scenarios. They found that all Gelisols are not alike: some Gelisols have soil materials that are very peaty, with lots of decaying organic matter that burns easily -- these will impart newly thawed nitrogen into the ecosystem and atmosphere. Other Gelisols have materials that are very nutrient rich -- these will impart a lot of nitrogen into the ecosystem. All Gelisols will contribute carbon dioxide and likely some methane into the atmosphere as a result of decomposition once the permafrost thaws -- and these gases will contribute to warming. What was frozen for thousands of years will enter our ecosystems and atmosphere as a new contributor.

"The scientific community researching this phenomena has made these international data available for the upcoming Intergovernmental Panel on Climate Change. As permafrost receives more attention, we are sharing our data and our insights to guide those models as they portray how the land, atmosphere, and ocean interact," said study lead Jennifer Harden, USGS Research Soil Scientist.

Source: **Science Daily**

FEATHERED BEAST

Ostrich dinosaurs

THE ostrich-like dinosaurs that roamed the Earth millions of years ago were adorned with feathers, used to attract a mate or protect offspring rather than for flight, according to the findings of Canadian scientists released on Thursday.

Researchers from the Royal Tyrrell Museum of Palaeontology, and the University of Calgary made the discovery in the 75-million-year-old rocks in the badlands of southern Alberta.

The ostrich-like dinosaurs, known as ornithomimids, were thought to be hairless, fleet-footed birds and were depicted as such in the Hollywood movie Jurassic Park.

But the researchers found evidence of feathers with a juvenile and two adult skeletons of ornithomimus, a species within the ornithomimid group.

"The discovery, the first to establish the existence of feathers in ornithomimids, suggests that all ostrich-like dinosaurs had feathers," according to a statement from the Alberta museum.

It said the specimens also revealed that the dinosaurs boasted a base of down-like feathers throughout their lifetime while older ones developed feathers on their arms, approximating wings.

But the dinosaurs would have been too large to fly, so the plumage might have been employed to attract a mate or in the protection of eggs during hatching.

The findings by the paleontologists Francois Therrien, curator at the Royal Tyrrell Museum, and Darla Zelenitsky, assistant professor at the University of Calgary, will be published on Friday in Science, a leading journal.

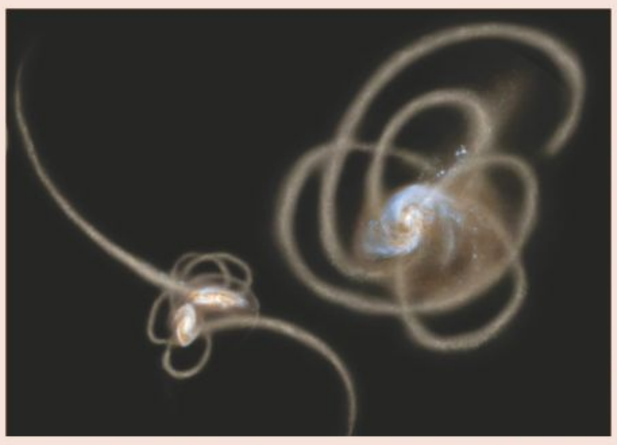
The fossils were discovered in sandstone and were the first feathered dinosaur specimens found in North America, according to the museum statement.

Source: **Reuters**

Dinosaurs with feathers.

SLUNG INTO THEDARK

Dark matter hole



NASA's Spitzer Space Telescope suggests that a mysterious infrared glow across our whole sky is coming from stray stars torn from galaxies.

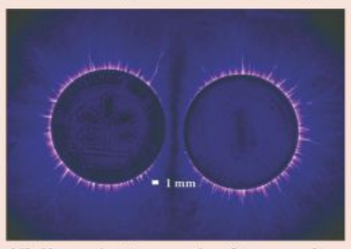
Stars ripped from their home galaxies as they collide with other galaxies can get slung into giant invisible cocoons of dark matter, researchers say, which might explain mysterious radiation pervading the sky.

These findings suggest the halos of dark matter surrounding galaxies are not completely dark after all, but contain a small number of stars, investigators added.

In recent decades, satellite telescopes have detected more infrared light emanating from the sky than known galaxies could account for. Scientists had suggested this strange glow might come from sources too dim for observatories to see directly for instance, the earliest, most distant galaxies.

DID YOU KNOW?

What is Kirlian photography?



Kirlian photograph of two coins exosphere.

Kirlian photography is a collection of photographic techniques used to capture the phenomenon of electrical coronal discharges. It is named after Semyon Kirlian, who, in 1939 accidentally discovered that if an object on a photographic plate is connected to a high-voltage source, an image is produced on the photographic plate.[1] The technique has been variously known as "electrography",[2]"electrophotography",[3] "corona discharge photography" (CDP),[4] "bioelectrography",[2] "gas discharge visualization (GDV)",[5] "eletrophotonic imaging (EPI)",[6] and, in Russian literature, "Kirlianography".