Nov/Dec 2018 • No. 248

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

I am sure everyone had a great holiday and start of the New Year. Let me take the opportunity to send you warm greetings and wish you a very Happy 2019. Yes, we are in 2019 already. For most of us, it is still a long way for the 2019 Annual Meeting of the Electrostatics Society of America, but the conference chairs are working hard to get everything organized well in advance. You may have already received an announcement regarding a call for abstracts and, in this newsletter, details are given on abstract submission and the conference venue. Please remember to visit the ESA web site and take note of the dates. Thanks to Kelly Robinson, Mark Zaretsky and Bill Vosteen, Conference co-chairs, and N. K. Kishore, Technical Program Chair, of the 2019 Annual Meeting of the Electrostatics Society of America that will be held from June 10-12, 2019 at Rochester Riverside Hotel, Rochester, NY, USA.

Something interesting I would like to share with our readers: Al Seaver, (past president) has digitized his collection of old ESA newsletters and Mark Zaretsky has managed to find the missing ones and have them digitized as well. Keith Forward is working to make these digitized versions accessible on the ESA website. Soon, our readers can enjoy knowing more and more about ESA through these archived newsletters. Thank you Al, Mark and Keith.

In 2018, the ESA council decided to have a virtual ESA council meeting; our first Virtual council meeting was held on Nov. 28th 2018. It was a great success, and the impact is being seen with the organization of our 2019 meeting and 2020 joint conference. This mid-year council meeting has helped us to keep on track with ESA activities.

Thanks to Kaz Adamiak for beginning the preparations on our next Joint Electrostatics Conference in Charlottetown, Prince Edward Island, Canada, in June 2020. The ESA will try its best to support the conference in any possible means to enable keeping the conference costs to a reasonable price considering the travel expenses. This is by no means saying the ESA will have travel supports; rather, we will try to minimize the cost of registration.

As always, this is my sincere request. Please lend your continued support to the ESA by participating at our meetings (as a presenter, exhibitor, or simply as an observer) and/or contributing to the newsletter (thoughts about the ESA or any topic concerning electrostatics).

For the Friendly Society
Shesha Jayaram, *shesha.jayaram@uwaterloo.ca*
President, Electrostatics Society of America

Calendar

- 2019 ESA Annual Meeting, June 10-12, 2019, Rochester Riverside Hotel, Rochester, NY, USA, Contact: Kelly Robinson, *kelly.robinson@electrostaticanswers.com*, http: *http://www.electrostatics.org/annualmeeting.html*
- EIC 2019, Elec Insul Conf, June 16-19, 2019, Hyatt Regency Calgary, Calgary, Alberta, Canada, Further info: *http: http://ieee-eic.org*
- ICDL 2019, IEEE Int'l. Conf. on Dielectric Liquids, June 23-27, 2019, Univ. of Roma, Rome, Italy, Contact: Massimo Pompili or Luigi Calcara, *icdl2019@uniroma1.it*, *https://www.icdl2019.org*
- 4th ISNPEDADM 2019, Oct. 7-10, 2019, Bonifacio, Corsica Island, France. Contact: Eric Moreau, *eric.moreau@univ-poitiers.fr*

ESA Officers

President:
Shesha Jayaram, Univ. of Waterloo
Vice President and Awards Chair:
Maciej Noras, Univ. of North Carolina
Executive Council:
David Go, Univ. of Notre Dame
Poupak Mehrani, Univ. of Ottawa
Rajeswari Sundararajan, Purdue Univ.

ESA Awards - Call for Nominations

Dear Friends,

The ESA is accepting nominations for the following awards:

The ESA Distinguished Service Award recognizes outstanding service to the ESA over an extended period of time, with a demonstrated long-term commitment to the growth and continued well-being of the Society (requirement: 10 years as ESA member).

The ESA Lifetime Achievement Award recognizes outstanding contributions to the field of Electrostatics, as shown by the pervasiveness of the contributions in understanding certain problems or important practical benefits resulting from the work (requirement: 10 years working in field of Electrostatics).

The ESA Honorary Life Member Award recognizes exceptional contributions to both the ESA and to the field of Electrostatics, sustained over much of a career (requirements: 10 years as ESA member, 20 years working in field of Electrostatics).

The ESA Rising Star Award recognizes significant contributions at an early stage of a career to the field of Electrostatics, Requirements: age of 40 or younger, but cannot be a student).

The ESA Entrepreneur Award recognizes companies and/or individuals that implement electrostatics- related technologies and are recognized as having a meaningful impact in the industry and/or academia.

The Teacher of the Year Award recognizes outstanding teachers who use Electrostatics to stimulate learning, inspire students, or otherwise encourage and energize the learning process in a formal educational setting in grades K-12 (requirement: 3 years teaching Electrostatics).

The Student of the Year Award recognizes middle or high school students who demonstrate outstanding achievement in Electrostatics, as showcased in laboratory projects, papers or presentations.

The ESA is also accepting nominations for induction to the Electrostatic Hall of Fame. This honor recognizes and records for posterity those individuals who have made extraordinary contributions to the field of Electrostatics. Nominees do not need to be still living. The Hall of Fame has three categories: (1) advancement of the fundamental knowledge of Electrostatics; (2) promotion of interest in the field of Electrostatics; (3) innovations using Electrostatics technology in industry.

The list of the award recipients is available at *http://electrostatics.org/esaawardwinners.html.* Nominations should be submitted electronically to the ESA Award Chair, Prof. Maciej Noras at *mnoras@uncc.edu*, by April 30, 2019. The nomination should be in the form of a letter from an ESA member that includes a description of how the accomplishments of the nominee satisfy the award requirements (including citations of publications or patents when relevant), the contact information of the nominator and nominee, and the names and contact information of 3 other ESA members who endorse the nomination. For the Teacher and Student awards, endorsements from two faculty members of the nominee's institution should substitute for the ESA member endorsements.

Thank you in advance for all the submissions,

Sincerely,
Maciej Noras

2019 Annual Meeting of the Electrostatics Society of America

Rochester Riverside Hotel, Rochester, NY

June 10-12, 2019

The Electrostatics Society of America (ESA) invites papers in all scientific and technical areas involving electrostatics for the 2019 Annual Meeting of the ESA. Contributions range from fundamental physics and new developments in electrostatics to applications in industry, atmospheric and space sciences, medicine, energy and other fields.

Anticipated Technical Session Topics

- Breakdown phenomena and discharges
- Electrically-induced flows and electrokinetics
- Contact charging and triboelectric effects
- Charge motion and static dissipation
- Gas discharges and microplasmas
- Atmospheric and space applications
- Biological and medical applications
- Materials synthesis and processing
- Material delectric properties
- Measurements and instrumenation
- Safety and hazards

Conference Information: Registration Fee and Housing options will be announced ~ 1/1/2019 and available at: http://www.electrostatics.org.

Student Presentation Competition: Presentations by undergraduate & graduate students are eligible for the *Student Presentation Competition*. Please identify the student presenter when submitting the abstract.

Important Dates

January 1, 2019	*Abstract submission open*
March 1, 2019	*Abstract submission deadline*
March 15, 2019	*Notification of abstract acceptance*
May 3, 2019	*Early registration deadline*
May 17, 2019	*Final manuscript deadline*

Abstract Submission

Online submission at http://www.electrostatics.org

Contact Information

Organizing Committee

Kelly	Robinson	Electrostatic Answers	kelly.robinson@electrostaticanswers.com
Bill	Vosteen	Monroe Electronics	billv@monroe-electronics.com
Mark	Zaretsky	Eastman Kodak	mark.c.zaretsky@gmail.com

Technical Chair

Prof. N. K. Kishore, PhD, Indian Institute of Technology, Kharagpur, India, kishor@ee.iitkgp.ac.in

About Rochester NY: On the southern shore of Lake Ontario in Western New York, Rochester (metro area population of just over 1 million) is New York's third most populous city. The University of Rochester and Rochester Institute of Technology have renowned research programs. Many important inventions and innovations originated in the Rochester area, and is the birthplace of Kodak, Xerox, Bausch & Lomb, Gleason, and Western Union.

Ferroelectricity - an 80-Year-Old Mystery Solved

Linköping University

Only now in 2018 have researchers successfully demonstrated that hypothetical 'particles' that were proposed by Franz Preisach in 1935 actually exist. In an article published in Nature Communications, scientists from the universities in Linköping and Eindhoven show why ferroelectric materials act as they do.

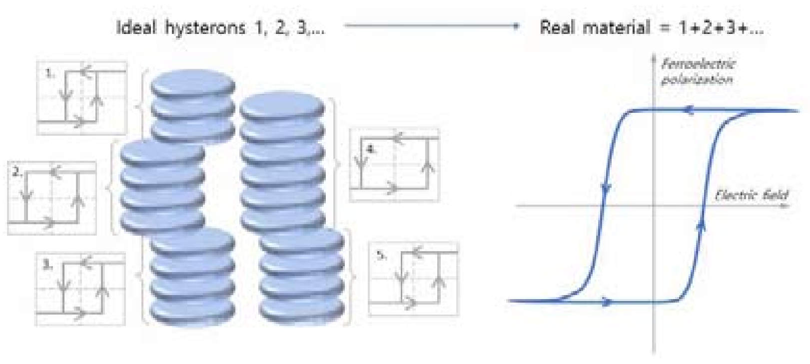
Ferroelectricity is the lesser-known twin of ferromagnetism. Iron, cobalt and nickel are examples of common ferromagnetic materials. The electrons in such materials function as small magnets, dipoles, with a north pole and a south pole. In a ferroelectric, the dipoles are not magnetic but electric and have a positive and negative pole.

In absence of an applied magnetic (for a ferromagnet) or electric (for a ferroelectric) field, the orientation of the dipoles is random. When a sufficiently strong field is applied, the dipoles align with it. This field is known as the critical (or coercive) field. Surprisingly, in a 'ferroic' material the alignment remains when the field is removed: the material is permanently polarized. To change the direction of the polarization, a field at least as strong as the critical field must be applied in the opposite direction. This effect is known as hysteresis: the behaviour of the material depends on what has previously happened to it. The hysteresis makes these materials highly suitable as rewritable memory, in for example hard disks.

For a piece of ideal ferroelectric material, the whole piece switches its polarization when the critical field is reached and it does so with a well-defined speed. In real ferroelectric materials, different parts of the material switch polarization at different critical fields, and at different speeds. Understanding this non-ideality is key to the application in memories.

A model for ferroelectricity and ferromagnetism was developed by the German researcher Franz Preisach as early as 1935. The purely mathematical Preisach model describes ferroic materials as a large collection of small independent modules called hysterons. Each hysteron shows ideal ferroic behaviour, but has its own critical field that can differ from hysteron to hysteron. It has been generally agreed that the model gives an accurate description of real materials, but scientists have not understood the physics on which the model is built: what are the hysterons? Why do their critical fields differ as they do? In other words, why do ferroelectric materials act as they do?

Professor Martijn Kemerink's research group (Complex Materials and Devices at LiU), in collaboration with researchers at the University of Eindhoven, has now studied two organic ferroelectric model systems and found the explanation. The molecules in the studied organic ferroelectric materials like to lie on top of each other, forming cylindrical stacks of around a nanometre wide and several nanometres long. "We could prove that these stacks actually are the sought-after hysterons. The trick is that they have different sizes and strongly interact with each other since they are so closely packed. Apart from its own unique size, each stack therefore "feels a different environment of other stacks, which explains the Preisach distribution", says Martijn Kemerink.



The organic ferroelectric material consists of nanometer-sized stacks of disk-like molecules that act as 'hysterons' with ideal ferroelectric behavior. Combined in a macroscopic memory device, the characteristic rounded-off hysteresis loop results. Credit: Indre Urbanaviciute och Tim Cornelissen

The researchers have shown that the non-ideal switching of a ferroelectric material depends on its nanostructure - in particular, how many stacks interact with each other, and the details of the way in which they do this.

"We had to develop new methods to measure the switching of individual hysterons to test our ideas. Now that we have shown how the molecules interact with each other on the nanometre scale, we can predict the shape of the hysteresis curve. This also explains why the phenomenon acts as it does.

We have shown how the hysteron distribution arises in two specific organic ferroelectric materials, but it's quite likely that this is a general phenomenon. I am extremely proud of my doctoral students, Indre Urbanaviciute and Tim Cornelissen, who have managed to achieve this", says Martijn Kemerink.

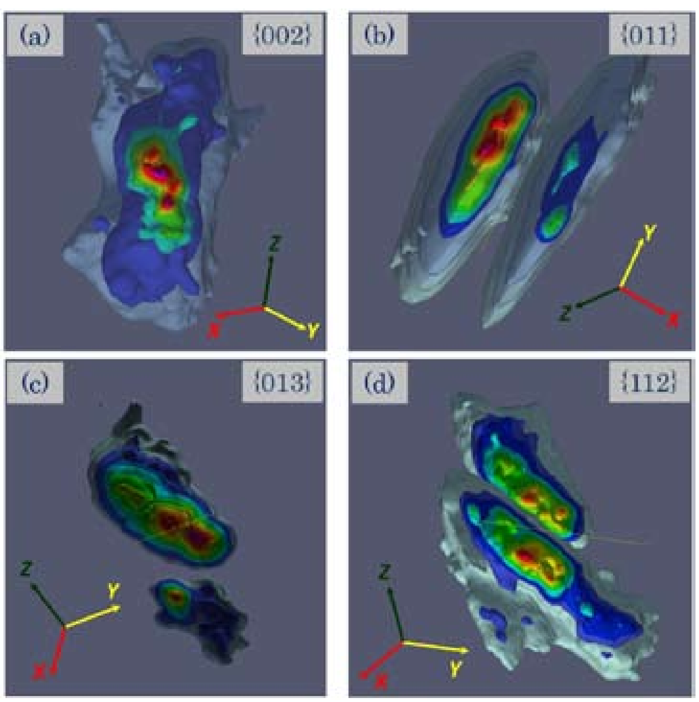
The results can guide the design of materials for new, so-called multi-bit memories, and are a further step along the pathway to the small and flexible memories of the future.

(from *https://www.rdmag.com/news/2018/10/ferroelectricity-80-year-old-mystery-solved*)

Scientists to track the reaction of crystals to the electric field

An international scientific team, which included scientists from China, Israel, England and Russia, has developed a new method for measuring the response of crystals on the electric field. The study, performed at the European Synchrotron Radiation Facility (ESRF), were published in the Journal of Applied Crystallography and appeared on the cover of the October issue. This method will help to implement new and improve existing functional materials.

"The study is dedicated to crystalline materials (ferroelectric), which are used in a variety of devices from sonars for submarines to elements of ultrasonic diagnostic devices," said researcher Dmitry Chernyshov of the



The international scientific team developed a new method for measuring the response of crystals on the electric field. Credit: Peter the Great St. Petersburg Polytechnic University

Swiss-Norwegian Beam Lines at ESRF and the Physical Electronics department of SPbPU. He stressed that improving the properties of such materials is an extremely important scientific task.

The scientist said that detailed three-dimensional scattering maps were collected during the synchrotron experiments at the ESRF. These maps carry detailed information about the structure of the crystal and its response to the electric field. Next, a mathematical method was invented for extracting the relevant information from such maps. The crystals under study were placed in a special cell for the application of electric field. The cell was developed by alumnus of St. Petersburg Polytechnic University Tikhon Vergentiev as part of his Ph.D. project during his internship at the ESRF.

The structure of crystals can be described in different spatial scales. It is possible to describe the structure at the atomic level or at the level of large blocks of the atomic structure (domains, boundaries between domains, structural defects). When the external conditions change (temperature, pressure, etc.), all components of the structure react differently. The research team studied the response of the material to an electric field in its atomic and domain structures.

"In the framework of one experiment, we were able to see how the different levels of the structural hierarchy react to external influences. If we measure and describe the response of individual components of a complex system, as well as their interaction, it is going to be possible to rationally control the structure and properties of such materials," said Dmitry Chernyshov.

(excerpted from *https://phys.org/news/2018-11-scientists-track-reaction-crystals-electric.html*)

Research team achieves record performance for 3D-printed graphene aerogel supercapacitors

Jeremy Thomas

Researchers at Lawrence Livermore National Laboratory (LLNL) and the University of California, Santa Cruz (UCSC) have created 3D-printed supercapacitor electrodes capable of achieving record-breaking performance and overcoming conventional tradeoffs for supercapacitors in the process.

In a paper published Oct. 18 by the online journal Joule, the joint research team demonstrated 3D-printed porous graphene aerogel structures capable of supporting ultrahigh levels of manganese oxide

(MnO2), a common pseudocapacitive material (a material that stores electric charge chemically and exhibits a high theoretical energy capacity). The result is a supercapacitor with the highest areal capacitance (electric charge storage per unit of area) recorded to date and a "remarkable" energy density compared with other types of capacitors. The breakthrough could open avenues to using supercapacitors as ultrafast-charging power sources for devices such as cellphones, laptops and other smaller electronics.

While capable of charging extremely quickly (requiring just a few minutes or seconds to reach full capacity) and retaining their performance even after thousands of charging and discharging cycles, supercapacitors are rarely used as batteries because of their relatively small energy density (storage capacity). But by 3D printing graphene aerogel scaffolds and loading the structures with the pseudocapacitive material MnO2, researchers said they're effectively packing more energy storage capacity into a relatively small area. The advancement, they said, addresses the typical energy storage vs. discharging/charging rate tradeoff for supercapacitors and approaches energy densities equal to that of some conventional batteries.

"We're trying to get the best of both worlds," said LLNL materials engineer Eric Duoss. "The remarkable part about this work is that all that surface area is accessible and active, so you get amazing volumetric and gravimetric properties and have things that can now take on a shape or form factor for a certain application environment. These capacitive materials are really unprecedented in that they can be enormously thick, relatively speaking, yet have record-setting performance characteristics."

The UCSC team used a chemical deposition method to load the porous 3D-printed structures developed at LLNL with up to 180 milligrams of MnO2. While this kind of mass loading typically leads to degraded performance due to sluggish ion diffusion, by depositing the pseudocapacitive material inside and outside the structures, researchers were able to reach unprecedented levels of loading — about 10-100 times more than others have achieved — without compromising performance. Researchers said the feat would be impossible through traditional manufacturing and points toward more commercially feasible energy storage materials for a broad range of applications.

By loading the 3D-printed lattice structures with manganese oxide, researchers were able to pack more energy storage capacity into a relatively small area, overcoming conventional tradeoffs for supercapacitors and approaching energy densities equal to that of some conventional batteries.

Traditionally, supercapacitor electrodes are built with thin, carbon-based films. To reach higher capacitance and energy density, engineers must stack multiple thin-film electrodes together, adding weight and costs. However, the excellent ion diffusion demonstrated in the LLNL/UCSC 3D-printed supercapacitor electrodes suggests they could be made thicker without affecting performance, researchers concluded. Significantly, researchers also discovered the areal capacitance increased linearly along with the loading of MnO2 and electrode thickness, suggesting widespread commercial potential and indicating that 3D printing an entire electrode at once could revolutionize the way supercapacitors are made.

"Our 3D-printed structures are not limited by accessible surface area because we have a lot of accessible macropores," said UCSC graduate student and co-lead author Bin Yao. "These pores are very important for the deposition of manganese oxide and for efficient ion diffusion. We can have a very thick electrode but still retain good conductivity and ion diffusion. Usually, as you get thicker and thicker, the capacitance will reach a plateau, especially at a high charging rate. But with a 3D structure, we can enable a good utilization of a higher charge. Even if we increase the thickness, it won't change the gravimetric value."

(excerpted from *https://www.llnl.gov/news/research-team-achieves-record-performance-3d-printed-graphene-aerogel-supercapacitors*)

The 'Skyrmion' May Have Solved the Mystery of Ball Lightning

Rafi Letzter

Scientists bound the magnetic fields of a supercooled quantum object into a complex knot. And what they found may have finally solved the centuries-old riddle of ball lightning, luminous orbs that sometimes linger in the atmosphere during thunderstorms.

That bizarre knot was a quantum object called a

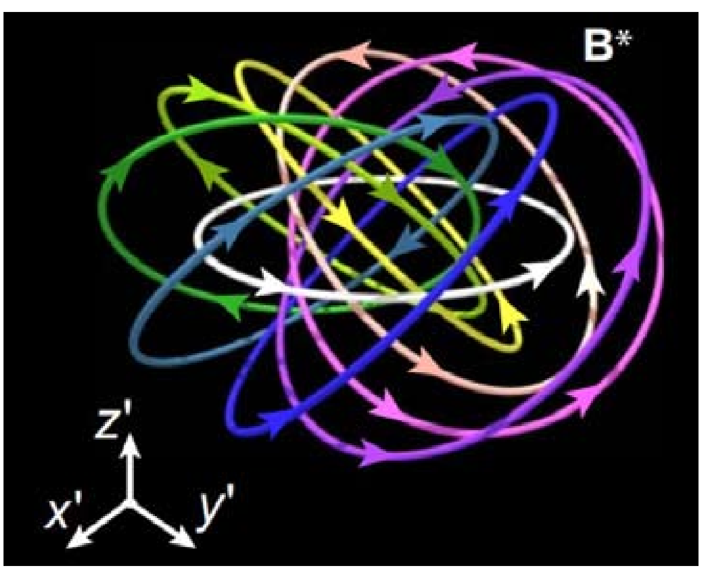
"Shankar skyrmion" that was first theorized in 1977, but that no one had ever managed to generate in a lab. A skyrmion is a tightly clustered group of circular magnetic fields, with each circle crossing each other circle exactly once, the researchers explained in a paper published March 2 in Science Advances . [Twisted Physics: 7 Mind-Blowing Findings]

Think about what happens when you hook one key ring around another key ring. Then imagine adding more and more rings, hooking each new one to all the existing rings. The resulting shape would look like the magnetic fields of the skyrmion — impossible to pull apart without breaking the rings.

But the skyrmion is different from those key rings in a critical way: It's twisted. The interlocking lines of magnetism turn along their routes, twice. If you flew a tiny atom-exploring spaceship along one, you'd do two corkscrews over the length of the circuit.

The researchers built the skyrmion out of a cloud of atoms supercooled into a dense blob called a "Bose-Einstein condensate" — a state of matter that emerges just at the edge of absolute zero, where the borders between atoms blend together, and quantum effects start to take place at a scale humans can more easily detect and observe.

Using techniques developed to build an exotic class of quantum magnet, the researchers nudged the spins, or magnetic orientations, of the atoms in the condensate until the interlocking rings of the skyrmion emerged. That's when it became clear that the skyrmion might be a good model for ball lightning.



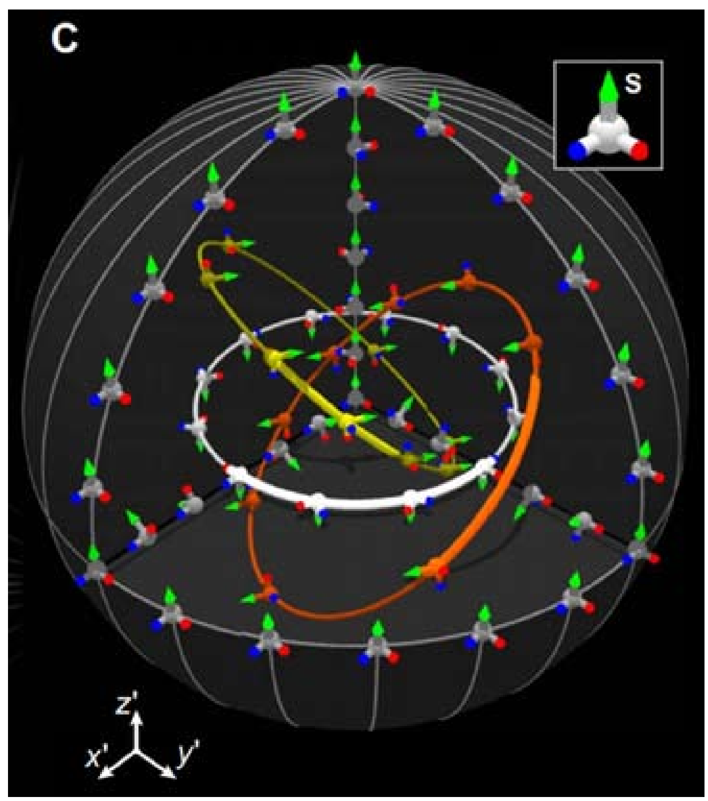
An image from the paper shows the interlocking magnetic fields of the skyrmion. Credit: Science Advances/Creative Commons

Ball lightning, as Live Science previously reported, is a rare and poorly understood weather phenomenon where a colorful glowing orb appears — usually during a thunderstorm — and appears to skitter through the air, far outliving the jagged bolt of lightning people are used to.

Back in 1996, a paper published in Nature proposed that ball lightning might be the result of the magnetic fields around the plasma of a lightning bolt curling into a knot and trapping it within, and proposed a model for what those knotted fields might look like.

The researchers reported that the fields they observed around their cold little skyrmion matched the model proposed in that paper, suggesting that hot ball lightning may, in fact, be a giant, naturally occurring skyrmion.

(from *https://www.livescience.com/61946-ball-lightning-quantum-particle.html*)



A figure from the paper shows the corkscrewing magnetic fields. See the blue bulbs depicted on the objects pictured moving along the field? Follow one around the circle to see how it turns. Credit: Science Advances/Creative Commons

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