

MONOPOLE MODULI

Bengaluru, September 14–25, 2026



The Virtual Booklet



TATA INSTITUTE OF FUNDAMENTAL RESEARCH

Minicourses

ANDREA FERRARI (DESY, Germany)

Berry phases in supersymmetric QFT, periodic monopoles and generalised cohomology

Tue 15 11:30, Wed 16 11:30, Thu 17 14:00, Fri 18 11:30

I will start by introducing the notion of Berry connection in quantum mechanics and quantum field theory — a connection on a vector bundle of ground states fibering over deformation parameters. Then I shall explain that 2d supersymmetric theories quantised on a circle and endowed with a symmetry have Berry connections which are generalised periodic monopoles. As we will see, when these theories can be defined as sigma-models with Kähler manifolds as target, physical observables (such as the ground states) are related to (generalised) cohomology theories of these target manifolds. I will conclude this series of lectures by discussing two different kinds of spectral data of generalised periodic monopoles and, for Berry connections arising from sigma-models, by finally relating these data to the geometry of the target manifold.

LORENZO FOSCOLO (University of Rome I “La Sapienza”, Italy)

Hypertoric geometry of Coulomb branches

Tue 15 15:00, Wed 16 15:00, Thu 17 15:00, Fri 18 9:00

We shall discuss construction and classification results for complete non-compact hyperkähler manifolds. We will focus on manifolds that admit an asymptotic geometry that generalises to higher dimensions the one of 4-dimensional ALF gravitational instantons such as the Taub–NUT and the Atiyah–Hitchin metrics. The 4-dimensional gravitational instantons have been recently classified and a relevant role in this theory is played by the Gibbons–Hawking ansatz, which allows one to describe 4-dimensional hyperkähler metrics with a circle symmetry explicitly. In higher dimensions, results are much more sporadic. In the minicourse we will discuss the role of higher dimensional generalisations of the Gibbons–Hawking ansatz, which can be used to construct examples with a torus symmetry, the so-called hypertoric varieties. We will also examine known examples arising from moduli spaces in gauge theory, such as monopoles, solutions to Nahm’s equations and moduli spaces of instantons on ALF spaces. Finally, we will discuss how a large class of examples is expected to arise from Coulomb branches of 3-dimensional quantum gauge theory in theoretical physics.

DEREK HARLAND (University of Leeds, UK)

L^2 geometry of hyperbolic monopole moduli

Tue 15 9:00, Wed 16 9:00, Thu 17 11:30, Fri 18 14:00

This minicourse introduces BPS monopoles on Euclidean space and hyperbolic space, and discusses their L^2 geometry. Monopoles are examples of topological solitons with origins in particle physics. The L^2 metrics on their moduli spaces can be used to study dynamics and are also geometrically interesting in their own right. This course will introduce some remarkable tools that can be used to construct monopoles, such as rational maps, spectral curves, and the Nahm transform. It will then review the L^2 geometry of Euclidean monopoles, before looking at some recent work on the L^2 geometry of hyperbolic monopoles.

SIQI HE (University of Leeds, UK)

The extended Bogomolny equation, Higgs bundles, and the Kobayashi–Hitchin correspondence

Tue 15 10:30, Wed 16 10:30, Thu 17 10:30, Fri 18 10:30 (online)

In this minicourse, we discuss the extended Bogomolny equations and their relation to Higgs bundles and the Kobayashi–Hitchin correspondence. These equations arise naturally as a dimensional reduction of the Kapustin–Witten equations and provide a bridge between gauge theory, complex geometry, and low-dimensional topology. We begin with a review of Higgs bundles on Riemann surfaces and the classical Kobayashi–Hitchin correspondence, which identifies stable Higgs bundles with solutions to Hitchin’s equations. We then introduce the extended Bogomolny equations on three-manifolds with boundary, emphasizing their geometric meaning and analytic structure. A central theme of the course is to explain how solutions to the extended Bogomolny equations can be interpreted in terms of holomorphic data, and how a version of the Kobayashi–Hitchin correspondence extends to this setting. We will also discuss boundary conditions, singular solutions, and their role in recent developments in gauge theory.

CHRIS KOTTKE (Rutgers University, USA)

Analytical aspects of monopole moduli spaces

Tue 15 14:00, Wed 16 14:00, Thu 17 9:00 and 16:30

In this minicourse we will consider the asymptotic geometry of the L^2 metrics on the moduli spaces of Euclidean BPS monopoles, emphasizing their “quasi-fibered-boundary” (QFB) structure. This QFB structure encodes a hierarchy of asymptotic regions of the moduli space, associated to cluster decompositions of monopoles with fixed charge into widely separated monopoles of lower charge. Accordingly, the metric admits asymptotics involving the metrics of lower charge moduli spaces. We will then discuss some implications for the analysis of harmonic forms on QFB manifolds with an eye toward Sen’s conjecture for the L^2 Hodge theory of monopole moduli spaces.

Outreach Activity

On Wednesday 16th our program hosts an outreach session titled **The Physics of Magnetic Monopoles**, starting at 16:30 (approx. duration: 75 minutes) and featuring two invited speakers:

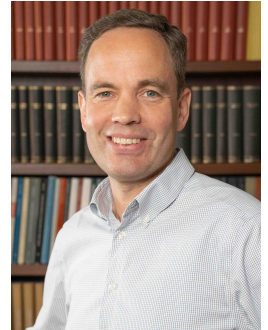
- Prof. Arttu Rajantie, a member of the MoEDAL experiment searching for magnetic monopoles produced in proton-proton and heavy-ion collisions at the Large Hadron Collider (LHC), the world's most powerful particle accelerator located at CERN, Geneva (Switzerland);
- Dr Max Bachmaier, a recent graduate from the Max Planck Institute for Physics, Garching (Germany); he has been involved in a collaboration studying the scattering of magnetic monopoles via numerical simulation of their field theory models, generating sophisticated computer animations of collision events.

ARTTU RAJANTIE (Imperial College, London, UK)

Magnetic monopoles: where are they?

Wed 16 16:30

Magnetic monopoles are among the most compelling predictions of theoretical physics, yet no convincing evidence for their existence has been found. In many ways, they are unlike any other hypothetical particle, with important implications for how they can be produced and detected. I will review the broad range of search strategies that have been pursued, from indirect astrophysical constraints to direct searches in cosmic rays and collider experiments. Particular emphasis will be placed on recent LHC searches based on the electromagnetic dual of the Schwinger pair-production mechanism, which provides a theoretically controlled framework for monopole production in strong electromagnetic fields. I will conclude by discussing the future prospects for monopole searches and the implications of a discovery for fundamental physics.



MAX BACHMAIER (EHU, Bilbao, Spain)

Magnetic monopoles: how do they collide?

Wed 16 17:15

The topological structure of magnetic monopoles (originally uncovered by 't Hooft and Polyakov) has remarkable consequences on their collisions; Manton suggested that their dynamics may be understood as motion through a geometric “moduli space” of all static monopole configurations of minimal energy compatible with such structure. In the mid-1980s, this proposal led Atiyah and Hitchin to construct the moduli space of two monopoles and to show that, in a head-on collision, two monopoles scatter at a right angle. Since then, a variety of monopole scattering processes has been explored. Advances in computational power and numerical techniques now allow us to simulate these scenarios directly. In this talk, I will explain the origin of right-angle scattering using simple illustrations and animations. I will then present the first fully field-theoretic simulations of magnetic monopole collisions, which provide a precise numerical test of the predictions that were based on the moduli space approach.



Keynote Lectures

ROGER BIELAWSKI (Leibniz University of Hanover, Germany)

Quasimonopoles and the asymptotics of monopole metrics

Mon 21 10:30, Tue 22 10:30

I shall introduce and discuss moduli spaces of quasimonopoles — hyperkähler manifolds which approximate the $SU(2)$ -monopole metric with exponential accuracy in appropriate asymptotic regions, and possess a torus symmetry required in the Segal–Selby approach to the Sen conjecture. This is joint work with Sergey Cherkis and Jacques Hurtubise.

CLIFF TAUBES (Harvard University, USA)

Analysis for the Vafa–Witten equations

Thu 24 16:30, Fri 25 16:30 (online)

I plan to explain and illustrate some of the salient analysis issues with regards to potential use of Vafa–Witten equation solutions to define smooth invariants for 4-dimensional manifolds. As it turns out, most of iconic gauge theory plays a role in the story: Bogomolny monopoles on $\mathbb{R}^3$, anti-self dual instantons on $\mathbb{R}^4$, flat $SL(2; \mathbb{C})$ connections on Riemann surfaces, and then some novelties ($\mathbb{Z}/2$ harmonic differential forms).

Research Talks

TBA — check this space

Schedule

Please note that Monday 14th is a local religious holiday (Ganesha Chaturthi), with no lectures. The program will adopt the following daily schedule throughout the two weeks, from Tuesday 15th:

07:30–09:00	breakfast (served at the cafeteria)
09:00–09:50	lecture slot 1
10:00–10:30	morning coffee/tea break (served by the lecture hall)
10:30–11:20	lecture slot 2
11:30–12:20	lecture slot 3
12:30–14:00	lunch (served by the lecture hall)
14:00–14:50	lecture slot 4
15:00–15:50	lecture slot 5
16:00–16:30	evening tea/snack (served at the cafeteria)
16:30–17:20	lecture/discussion slot 6
19:00–21:00	dinner (served at the cafeteria)

The assignment of slots will be as follows.

Week 1: Minicourses and outreach session

Slots	Monday 14	Tuesday 15	Wednesday 16	Thursday 17	Friday 18
1	tea	Harland I	Harland II	Kottke III	Foscolo IV
2		He I	He II	He III	He IV
3		Ferrari I	Ferrari II	Harland III	Ferrari IV
4		Kottke I	Kottke II	Ferrari III	Harland IV
5		Foscolo I	Foscolo II	Foscolo III	
6		check-in class	Rajantie + Bachmaier	Kottke IV	

Additional events:

Mon 14, 09:50	Arrival tea and informal welcome by the Organisers
Tue 15, 09:50	Check-in class (for the more junior participants)
Wed 16, 16:30	Outreach session — <i>The Physics of Magnetic Monopoles</i>
Mon 21, 09:00	Official welcome session by ICTS Director Prof. Rajesh Gopakumar

Exploring Bangalore

The city of Bangalore has made its reputation for other reasons than being an obvious tourist destination, but it is nonetheless worth exploring for some colonial architecture, parklands and art galleries — as well as for shopping. Such an outing is straightforward to organise: you can just take advantage of the free shuttle connecting ICTS with IISc, another research institute in a more central location, and then perhaps move forward by cab/auto-rickshaw or using the Metro, which is easy to navigate.

The local holiday on Monday 14th (officially the first day of our program!) marks Ganesha Chaturthi, a vibrant religious festival honouring the elephant-headed Lord Ganesha, the revered overcomer of troubles. While major Ganesha-centric shrines—like the mammoth Sri Dodda Ganapathi Temple in Basavanagudi—will be massively overcrowded with hours-long ritual queues, the day can offer a fascinating window into local culture. A uniquely Bangalore curiosity is the small Sri Prasanna Ganapati Temple in Koramangala, famously dubbed the “techie Ganesha” because local students, software professionals and startup founders flock there specifically to pray for job offers, promotions, and exam or corporate success. If you are interested in observing the festive ceremonies without the overwhelming holiday rush, a smart option is to visit one of the city’s other historic, non-Ganesha temples, most of which house their own smaller Ganesha shrines. One example is the Sri Dakshinamukha Nandi Tirtha in nearby Malleshwaram, accessible by a 5-minute auto-rickshaw ride from IISc. This unique Shiva temple was buried underground for centuries and only rediscovered during an excavation in 1997; it features a mysterious, continuous stream of fresh water flowing from the mouth of a stone Nandi bull directly onto a Shiva Linga, collecting in a stepped stone pool filled with turtles and fish. It remains a serene, low-key oasis even on major public holidays. After exploring this temple, you can head just up the road to Sankey Tank, a sprawling man-made lake surrounded by lush greenery. Alternatively, if you prefer to avoid the city rush altogether, you could just venture into one of the villages surrounding the ICTS campus to experience traditional, community-led decorations and music in a much calmer, rural atmosphere.

If you are thinking of visiting museums and galleries, note that the local Government Museum is currently closed for a massive renovation and curation upgrade. Most trending right now is the Museum of Art & Photography (MAP), a private institution showcasing Indian art and culture, both traditional and modern. (Note that it is closed on Mondays, so it is not an option for your holiday plans.) It regularly hosts a number of parallel exhibitions, with a strong focus on contemporary artists and leveraging digital technology. If you cannot visit in person (perhaps because you are attending our program remotely!), we still encourage you to have a virtual tour of the collection on their well-developed website: <https://map-india.org/>

Weekend: Suggestions

S³ excursion: Sravanabelagola, Srirangapatnam and Somnathpur

On Saturday 19th we will organise a bus tour to a small number of cultural sites in Karnataka. Please note that this is a full-day programme, requiring departure from ICTS at 6:00 am sharp!

We will head first to Sravanabelagola (arrival around 7:30 am, a good time for a packed breakfast — please bring your own; fresh fruit is available there from local vendors) to explore two historic hills, Indragiri and Chandragiri, steeped in over two millennia of Jain tradition. Climbing 700 granite steps barefoot up Indragiri rewards you with a close view of the Gommateshwara statue, a magnificent 10th-century monolith and one of the largest free-standing sculptures in the world. Chandragiri holds a walled complex of 14 Jain shrines, mostly in Dravidian style.

Our next stop will be Srirangapatna, a historic fortified island serving as local capital at various times. Located near the ancient Sri Ranganathaswamy Hindu temple (which we will visit), the city is famously known as the stronghold where Tipu Sultan, with some French assistance, staged his late 18th-century resistance against British conquest. We will tour Tipu's Summer Palace to admire its stunning wooden architecture and colorful murals depicting grand battle scenes.

We will next head to Somnathpur to visit its Keshava temple, built in the mid-13th century in the ornate Hoysala architectural style that Southern Karnataka is famous for. The building is no longer in active religious use, but it is considered to be the best-preserved of three Hoysala temples (the others are at Belur and Halebid) that together now a single UNESCO World Heritage Site.

On the way back to ICTS, we will stop at the popular Empire Restaurant near Maddur for a hearty North Indian and Mughlai dinner — our main meal of the day.

Estimated cost per person: TBA.

Hampi adventure

Hampi is the name given today to the village next to the ruins of the once great city of Vijayanagara, the capital of a vast empire controlling most of Southern India and marking the golden age of medieval Hindu civilization. The magnificent old city, which might have reached one million inhabitants at its zenith, was plundered and then razed to the ground in 1565 after a clash of cultures with the sultanates of the Deccan. It was among the first heritage sites in India to make it to the UNESCO list, and is arguably the most rewarding tourist destination in Karnataka. You need at the very least two full days to explore the richness of this site and to enjoy its pleasant rural surroundings.

The trip is usually feasible by night train from Bangalore (with berths, leaving late on Friday and coming back in the early hours of Monday); however, we have just checked that the regular tickets for this so-called 'Hampi express' have already sold out for the weekend within our program — the booking status has moved to a waitlist across the major AC seating tiers. An alternative is to book a tatkal ticket or make the same route by coach, which usually takes less time than the train, and can be booked at short notice. You would need to organize the trip by yourself, including (very basic) accommodation for one night in the area.

Mysore: downward dogs and glittering elephants

Mysore is a classic day-trip destination from Bangalore, the two cities being well connected by both expressway and a brisk rail line. As the global birthplace of Ashtanga Vinyasa (or simply “Mysore style”) yoga, it sells itself as a wellness paradise. Enthusiasts at all levels can drop into various affordable shalas, be it for a single class or a weekend of zen.

For a complete change of vibe, explore Mysore Palace — a sprawling spectacle of Victorian scale and Indo-Saracenic grandeur, with a private wing still occupied by the Maharaja. Catch it at its glittering best on the Saturday night during its Sound and Light Show (19:00-20:00 for the English version). This time of the year, you will witness the buildup to the Dasara festival: the city’s famous royal elephants are already in residence at the palace, and you can watch them in the mornings as they practice their heavy-lifting routines for the upcoming pageantry in October.

If you are undecided between this “Mysore pak” (a popular local sweet!) and our S^3 excursion, you could consider joining S^3 but leaving it at S^2 , making your way to Mysore in the afternoon after visiting Srirangapatnam, at relatively close distance.

Practicalities

- Venue for the lectures/talks: Ramanujan Lecture Hall
- Address: ICTS, Survey No. 151, Shivakote, Hesaraghatta Hobli, Bengaluru 560 089, India
- Email contacts:
 - ICTS Programs Office: moduli@icts.res.in (dedicated to our program)
 - ICTS Guest House: guesthouse@icts.res.in (a printer is available here)
- Phone contacts:
 - ICTS Reception: +91 80 4653 6000
 - ICTS Front Desk: +91 89 7006 0300 (also on WhatsApp; only 9:30 am to 5:30 pm)
 - ICTS Program Office: +91 80 4653 6052 (Dhananjayan CP)
 - ICTS Guest House Reception: +91 80 4653 6400 (available 24/7)
 - ICTS First-Aid Centre: +91 80 4653 6102
 - ICTS Security: +91 80 4653 6100 (emergency issues, bicycles)
- Program webpage: <https://www.icts.res.in/program/Mnpl2026>



- Shuttle service ICTS $\leftrightarrow$ IISc: <https://www.icts.res.in/facilities/transport>
- Train travel: <https://www.ixigo.com/trains>

Train tickets have various price categories (depending on the train and level of comfort, among other things). Popular routes often sell out; in this case, one can consider getting a waitlist ticket. Alternatively, one could get a *tatkal* ticket; this category of tickets only becomes available on the day before the journey after 10 am, and it incurs an extra fee.
- Swimming pool: it is free to use by ICTS guests. Please note that wearing a swimming cap is compulsory; you can buy one from the reception for ₹160.
- Cycling: you can borrow a bike for free from the security officer (phone contact above) at the main gate; a helmet and a lock will be provided.
- Laundry: washing machines, laundry soap and drying racks are available at the guest house.
- Money: there is an ATM at the ICTS campus, by the entrance to the Sports Centre.
- Coffee: perhaps the best option within the ICTS campus is the bar/cafeteria of the academic block, which has a functioning espresso machine (₹10 for a cup).
- On-site Wi-Fi access: SSID: MNPL – 2026 Password: Mn@25\$me
- Slack workspace: <https://monopolem.slack.com>