

YEAR SIX PRELIMINARY REPORT
ON THE SIMONS COLLABORATION
“SPECIAL HOLONOMY IN GEOMETRY, ANALYSIS, AND PHYSICS”
ANNUAL MEETING AND INITIAL WORKSHOP (SEPTEMBER 9–15, 2021)

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1. Introduction

This is a brief update on the activities of our Simons Collaboration that have taken place since our fifth Annual Report was filed in June 2021. There have been two ‘hybrid’ events (i.e., a combination of in-person and remote participants): an annual meeting at the Flatiron Institute September 9–10 and the initial year-six workshop of the collaboration held at the Simons Center for Geometry and Physics in Stony Brook, NC, September 12–15.

During the day-and-a-half annual meeting, we presented a series of eight talks, mostly by collaboration PIs, about the important developments in the collaboration’s research program in the past year.

The format of the week-long workshop was our now-traditional “Progress and Open Problems.” See below for an expanded description.

2. Fifth Annual Meeting

This meeting was held September 9–10, 2021 at the Flatiron Institute in NY, NY.

- Organizer: Robert Bryant (with assistance from the other PIs of the collaboration)
- Themes: Solitons in the G_2 -Laplacian flow, the physics of singularities in special holonomy, the structure of moduli of pseudo-holomorphic curves, the geometry of collapse of four-dimensional hyperkähler manifolds, Higgs bundles on Spin (7)-manifolds and the geometry of the G_2 -Hull-Strominger system
- [Meeting Page for the 2021 Annual Meeting](#)¹
- Speakers (the presentation slides have been submitted to the foundation):
 - Mark Haskins (PI), Solitons in Bryant’s Laplacian flow
 - Bobby Acharya (PI), The Physics of some G_2 and SU (3) holonomy singularities (This lecture had to be remote because of COVID-19 travel restrictions.)
 - Thomas Walpuski (PI), The Gopakumar–Vafa finiteness conjecture
 - Ruobing Zhang (former Collaboration postdoc), Collapsing geometry of hyperkähler manifolds in dimension four
 - Mohammed Abouzaid (guest), Lagrangian fibrations from the perspective of Floer theory
 - Mirjam Cvetič (PI), Zero modes of Higgs bundles on local Spin (7)-manifolds
 - Jason Lotay (PI), Some remarks on contact Calabi-Yau 7-manifolds
 - David Morrison (PI), Non-Perturbative heterotic duals of M-Theory on G_2 orbifolds (This lecture had to be remote because of illness of the speaker.)
- Participants: There were 25 in-person participants and 50 remote participants. (The average viewing time among the 50 remote participants was 325 minutes per viewer.)

Date: September 23, 2021.

¹ <https://www.simonsfoundation.org/event/simons-collaboration-on-special-holonomy-in-geometry-analysis-and-physics-annual-meeting-2021/>

3. Initial Year-Six Workshop

September 11–15, 2021 (Simons Center for Geometry and Physics)

This three-and-a-half-day workshop was organized as a collection of 13 presentations on recent progress and challenges that it would be desirable to address interspersed with two curated discussion sessions. All the talks were recorded and are posted on the collaboration website (see below). In contrast to the annual meeting, most of the lectures were by present and former postdocs and graduate students of the collaboration. The discussion sessions, though planned to be focused on specific topics, were more informal and were intended to pose and discuss some interesting problems that our recent progress may have brought within reach.

- Title: Progress and Open Problems
- Organizers: Mark Haskins
- Themes: special bundles and metrics, calibrated submanifolds, collapsed limits and singular metrics, applications to physics
- Speakers:
 - Gavin Ball (University of Wisconsin, Madison), Associative submanifolds of the Berger space
 - Xuemaio Chen (University of Maryland), Compactness for Ω -Yang-Mills connections
 - Tristan Collins (Massachusetts Institute of Technology), Calabi–Yau manifolds through conifold transitions
 - Siqi He (Stony Brook University), The branched deformations of special Lagrangian submanifolds
 - Jonathan Heckman (University of Pennsylvania), Quantum reflections in 3D QFTs and their local $\text{Spin}(7)$ counterparts
 - Max Hübner (University of Pennsylvania), Higgs bundles for G_2 -manifolds and brane/particle probes
 - Fabian Lehmann (Stony Brook), Non-compact $\text{Spin}(7)$ -manifolds
 - Yang Li (Massachusetts Institute of Technology), The SYZ conjecture and non-Archimedean geometry (This talk doubled as the Stony Brook Departmental Colloquium.)
 - Zhenhua Liu (Princeton University), Every finite graph arises as the singular set of a compact 3D calibrated area minimizing submanifold
 - Daniel Platt (Imperial College, London), New estimates for G_2 -structures on resolutions of orbifolds
 - Song Sun (University of California, Berkeley), Collapsing geometry of four-dimensional hyperkähler manifolds, Part 2
 - Thomas Walpuski (Humboldt University of Berlin), The Gopakumar-Vafa finiteness conjecture
 - Jingxiang Wu (Perimeter Institute/Oxford University), Kondo line defect and affine oper/Gaudin correspondence
- [Meeting Page for September 2021 Workshop at SCGP²](#). The videos of the lectures are posted here.
- Participants: There were 20 in-person participants and 50 remote participants. (The average viewing time among the 50 remote participants was 445 minutes per viewer.) See Table 2 for the list of the participants.

* denotes speaker

² <https://sites.duke.edu/scshgap/progress-and-open-problems-2021-september-12-15-2021-scgp-stony-brook/>

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