

Proposal --- MSRI Summer School on Subfactors

We propose to hold a two week summer school on subfactors, planar algebras, and tensor categories, with 3 parallel lecture series to be given by Noah Snyder (Indiana), Dmitri Shlyakhtenko (UCLA), and Emily Peters (Loyola University Chicago). The organisers are Noah Snyder and Scott Morrison (who will not be lecturing). Ideally this school would be held in 2017, although 2018 is also feasible for the organisers and speakers.

Overall structure

We plan to have three lecture series consisting of six lectures each along with approximately 6 one-off lectures by graduate students and the TA. Each day we will have 2 or 3 talks, interleaved with problem sessions and small group work.

Lecture series

One lecture series will be given by Dima Shlyakhtenko on the operator algebraic context of subfactors and analytic aspects of subfactor theory. One will be given by Emily Peters on Jones's planar algebras and skein theoretic approaches to subfactors. One will be given by Noah Snyder on fusion categories and algebra objects and their relationship to subfactors. Each series would consist of roughly half a dozen lectures, and due to the variety of background needed for the three threads would start with two basic introductory lectures before moving on to more advanced topics.

In more detail:

- Dima's lecture series would discuss von Neumann algebras and factors, subfactors, bimodules, symmetric enveloping algebras, and the generalization of key group theoretic notions like amenability and property (T) to subfactors via the representation theory of subfactors.
- Emily's lecture series would cover planar algebras, skein theoretic descriptions of certain small planar algebras, the index theorem, and the skein theoretic approach to the Haagerup and extended Haagerup subfactors.
- Noah's lecture series would cover fusion categories, algebra objects, module categories, bimodule categories and the Brauer-Picard groupoid.

We anticipate that after these lecture series the students would be able to read Popa-Vaes's recent work on amenability and property (T) for subfactors, Bigelow-Morrison-Peters-Snyder's construction of the extended Haagerup subfactor, and Ostrik's classification of module categories for $\text{Rep}(G)$.

Problem sessions

Each day we plan to have two problem sessions based on the material from that day's lectures.

The lecturers will prepare appropriate problems for the students to work on in small groups in the first of the two problem sessions. We will ask the lecturers to prepare problems with a range

of difficulties, and we will assist students in choosing an appropriate problem for their level of background. We anticipate that the lecturers and TA will move between the groups giving advice, and at the end of each session the groups will briefly report to the whole school on their results.

The second session will be organised as we have successfully run afternoon sessions at AIM ("[Classifying small fusion categories](#)", 2014) and at Banff ("[Subfactors and Fusion Categories](#)", 2014). All participants will be able to propose questions and topics which will we list on a board. We will then divide the school into working groups for the four most popular topics. The lecturers and TA (David Penneys) will each allocate themselves to one group. These sessions may cover particularly difficult problems remaining from the morning session, or topics which the students indicate they would like deeper explanation of.

Student lectures

We will give more advanced graduate students an opportunity to talk about a topics which are related to the lecture series. The exact topics will depend on which graduate students are attending and so will be chosen closer to the time. We will hold these talks on the first Friday and on the Thursday and Friday of the second week.

Budget

Our proposal calls for 3 domestic speakers, and one TA. This will require travel expenses for 4 (two from LA, one from Chicago, one from Indiana) and hotel expenses for 3. We anticipate two out of the three speakers having NSF summer funding, so only needing one honorarium. The TA will be paid \$600/week, for both weeks.

Our preliminary estimates for the budget are as follows.

Flights (rounding up quotes from Kayak for June 2015)	
LAX-OAK * 2	600
Indianapolis-OAK	800
Chicago-OAK	500
Taxis/local transport	400
Hotels (3*14*150?)	6300
Meals and incidentals (4*14*61)	3416
Honorarium * 1	1000
TA salary	1200
Total	14216

(The second organiser, Scott Morrison, may or may not attend the whole time, and should be assumed to be self-funding for now.)

Pre-proposal

We propose four lecture series, with two on analytical issues in subfactors and von Neumann algebras more generally, and two covering algebraic aspects of subfactors.

A tentative speaker list might be:

Stefan Vaes (KU Leuven)

Jesse Peterson (Vanderbilt)

Noah Snyder (Indiana), title "Algebra objects in tensor categories, and the representation theory of subfactors"

Scott Morrison (Australian National University), title "Planar algebras and subfactors"

We can ask Stefan and Jesse if they would be interested in participating in such a program, and their response would likely refine the proposed contents of the first two lecture series. Stefan's series would concern analytic aspects of subfactors, while Jesse's would cover a non-subfactor topic in von Neumann algebras.

Jesse's talks would begin with the definition of a von Neumann algebra, Stefan's with the definition of a subfactor, Noah's with that of a tensor category, and Scott's with that of a planar algebra. By the second lecture or so everyone would be able to indicate the connections with the other lecture series. We may also have to add some material at the beginning to bring students up to speed (for example, if there are students who don't already know what a functor is, or a subalgebra of $B(H)$, etc). We like the idea of having tutorials and/or problem sessions in the afternoons.

If this looks reasonable, we'll start talking to them. Both Stefan and Jesse give excellent lectures. Also let us know if you think the speaker choice should be changed. Dima Shlyakhtenko (UCLA) would be a good alternate for either Stefan or Jesse.

Invitation to lecturers

Dear Dima, Emily, and Dave

Pavel Etingof has asked us to propose an MSRI summer school on subfactors and von Neumann algebras, likely to run in summer 2017 or summer 2018. Dima and Emily, would you be interested in giving a lecture series (probably 5-6 lectures, over two weeks)? Dave, would you be interested in being the TA for the school?

Our initial idea is that Dima would talk about von Neumann algebras and analytic aspects of subfactors, Emily about subfactor planar algebras and skein theory, and Noah tensor categories, algebra objects, and module categories.

The format would be to have 2 or 3 lectures each morning over 10 days, and run tutorials and small groups in the afternoon. The TA would have primary responsibility for the tutorials, but of course the lecturers would also be involved. The summer school will be held at MSRI, with around 20-30 students. Some of the students would also be invited to give talks.

The MSRI can pay travel expenses, a \$1000 honorarium for lecturers without summer salaries, and \$600/week for TAs.

If you're interested (even if conditional on being able to work out the logistics), please let us know. An outline of the material you'd like to cover (just paragraph-long) would be fantastic, as that will help us put together the proposal for the MSRI committee, which we are supposed to do by the end of April. (We'll write something ourselves if you're busy at the moment.)

best regards,
Scott and Noah

From Eisenbud:

"I would like to see the afternoons fleshed out in a way that assures that the students will work together in small groups, with mentorship from the lecturers —“problem sessions or tutorials in the afternoons” doesn't quite get at what I think works best in these programs."
