**课程名称**：Introduction to Knots, Knotoids and Virtual Knots

**上课日期：**2 June -14 June，2019

**课程简介**：

1. Introductory Material

(a) Formulation of knot theory in terms of embeddings of circles in three dimensional space. Isotopy generated by piecewise linear triangle moves.

(b) Formulation of knot theory in terms of Reidemeister moves on knot and link diagrams. Proof of this combinatorial formulation by projection and

the use of the triangle moves.

(c) Basic invariants of knots and links: linking number, fundamental group, Fox coloring, Quandle.

(d) Spanning surfaces for knots and Seifert’s algorithm.

(e) Rational Tangles and their fractions. Hints of the applications of rational tangles and rational knots to DNA recombination.

(f) Combinatorial properties of diagrams, including moves on arc diagrams and description of the Dynnikov unknotting algorithm.

2. The Jones Polynomial and the Kauffman Bracket

(a) Definition and Kauffman Bracket State summation. Properties of the bracket. Examples. Relation with the Jones polynomial.

(b) Alternating and Adequate knots and links and their bracket polynomials.

(c) Temperley Lieb algebra and representation of Artin Braid Group to Temperley Lieb algebra.

(d) Relationships with Tutte polynomial and the Potts Model.

3. Introduction to Virtual Knot Theory and to Knotoids.

(a) Definitions and surface interpretations for virtual knots and links. Different categories of virtuals and related structures such as welded knots and links.

Basic invariants of virtuals including Odd Writhe, Jones polynomial and Manturov Parity Bracket.

(b) Knotoids and their virtual closures. Applications to polymer chains and proteins.

(c) Affine Index polynomial and cobordism of virtual knots.

(d) Arrow polynomial.

(e) Relationships with Tutte polynomial and polynomials for signed cyclic graphs.

4.Introduction to Khovanov Homology for Classical and Virtual Knots.

(a) Definitions and description of gradings, Frobenius algebra and methods of calculation.

(b) Results about cobordism of virtual knots via Khovanov homology.

(c) Relationships with Tutte polynomial, Dichromatic Polynomial and Perfect Matching Polynomials.

5. Applications and Relations of Knot theory and Quantum Computing

(a) Review of basic quantum theory.

(b) Description of simple quantum algorithms.

(c) Constructions of unitary representations of the Braid group — including Majorana Fermions and the Fibonacci Model via the bracket polynomial and Temperley Lieb Recoupling Theory.

(d) Topological Quantum Computing.

6. Vortices and Vortex Reconnection

(a) Physical background and movies of vortices.

(b) Knot cobordism and reconnection numbers for vortices

**主讲教师及简介：**

Louis H Kauffman, 美国伊利诺伊大学芝加哥分校教授，著名拓扑学家。1966年MIT学士，1972年普林斯顿大学博士。美国数学会会士。JKTR期刊founding Editor。已发表论文280多篇，引用3700多次。Kauffman教授在很多方面做出了很有影响的工作。例如：他引入了括号多项式，并由此建立了Jones多项式（Jones因此于1990年获Fields奖）的状态模型。该工作将Jones多项式初等化，沟通了和统计物理以及组合图论的联系。

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**赞助单位：**

国家自然科学基金

国家天元数学东南中心

厦门大学数学科学学院

**课程名称**：拟阵入门

**上课日期：**2 June -8 June，2019

**课程简介**：

A matroid is a structure that generalizes the notion of [linear independence](https://en.wikipedia.org/wiki/Linear_independence) in vector spaces. Matroids have found applications in many mathematical subjects such as geometry, [topology](https://en.wikipedia.org/wiki/Topology), [combinatorial optimization](https://en.wikipedia.org/wiki/Combinatorial_optimization), [network theory](https://en.wikipedia.org/wiki/Network_theory) and [coding theory](https://en.wikipedia.org/wiki/Coding_theory). I will give a series of talks for the beginners of Matroid theory. These talks cover the following topics:

1. Definition of matroids and equivalent statements;
2. Basic concepts: bases, rank function, closures, etc;
3. Transversal matroids;
4. The lattice of flats;
5. Duality.

**主讲教师及简介：**

董峰明，现为新加坡南洋理工大学副教授、博士生导师。1997年新加坡国立大学博士。主要研究兴趣为图论，特别是图和拟阵的结构与多项式的关系。和他人合作，已出版专著和其他书籍四本, 已发表论文近70篇，其中约20篇发表在JCTA, JCTB, JGT 等组合数学的顶级刊物上。解决了若干公开问题及猜想， 包括Welsh和Bartel提出的“Shameful Conjecture”，是图的色多项式领域的著名专家。2008年，受邀访问英国剑桥大学牛顿数学科学研究所。最近他被邀请参与撰写《[the CRC Handbook on the Tutte Polynomial and Related Topics](http://www.edmgr.com/TUTTE/mainpage.html)》 手册，是该书的亚洲区唯一作者。

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