이 윤 원 (인하대학교) (월 9:00-9:50, 11:10-12:00, 화 9:00-9:50)

The small time heat trace asymptotics and spectral invariants

The zeta-determinant and eta-invariant are global spectral invariants of the Laplacian and Dirac operator, respectively, on a compact Riemannian manifold, which play important roles in geometry, topology and theoretical physics. The definitions of these invariants are given by the small time heat trace asymptotic expansions of Laplacians.

In the first lecture, I will go through the small time heat trace asymptotic expansions on a compact Riemannian manifold with boundary with the Dirichlet or Atiyah-Patodi-Singer boundary condition if the boundary is non-empty. The coefficients of these asymptotic expansions are given by some curvature tensors including the scalar curvatures and principal curvatures on the boundary, from which the spectral invariants are closely related with some geometric invariants.

In the second lecture, I will discuss the eta-invariant of the Dirac operator on a closed Riemannian manifold which is the boundary of 4 k-dimensional manifold. The eta-invariant was introduced by Atiyah, Patodi and Singer as a defect term in the Hirzebruch signature theorem on a compact $4k$-dimensional manifold with boundary. I will define the eta invariant by using the heat trace asymptotics and go through some basic properties of the eta-invariant and finally discuss the gluing formula of the eta-invariant.

In the third lecture, I will discuss the zeta-determinant of a Laplacian on a compact Riemannian manifold with boundary. The zeta-determinant is introduced by Ray and Singer to define the analytic torsion and is defined by using the heat trace asymptotic expansion. The zeta-determinant also plays an important role in theoretical physics relating to Casimir effect. In this lecture, I will go through the definition and basic properties of the zeta-determinant and analytic torsion and discuss the gluing formula of the zeta-determinant.

김 종 수 **(서강대학교)** (월,화 10:05-10:55)

Quasi local mass, scalar curvature rigidity and static spaces

Quasi local mass 와 Brown-York mass는 간략히 설명합니다.

주요 부분은 scalar 곡률의 rigidity/non-rigidity 와 static space 를 다루는 것입니다. 특히 아래의 내용들을 다룰 것입니다:

1. Brendle - Rigidity phenomena involving scalar curvature
2. Brown and York - Quasilocal energy and conserved charges derived from the gravitational action
3. Wang and Yau - Quasilocal mass in general relativity
4. Shi and Tam - Positive mass theorem and the boundary behaviors of compact manifolds with nonnegative scalar curvature
5. Corvino - Scalar curvature deformation and a gluing construction for the Einstein constraint equations
6. Qing and Yuan - On scalar curvature rigidity of vacuum static spaces
7. Miao, Shi, Tam - On geometric probelms related to Brown-York and Liu-Yau quasi local mass
8. 기타 static space의 example들에 관한 결과들

박 병 도 **(고등과학원)** (월,화 19:00-19:50, 목 10:05-10:55)

Introduction to differential cohomology

Differential cohomology is a topic that has been attracting a considerable interest. Many interesting applications in mathematics and physics have been known; description of WZW terms, string structures, study of conformal immersions, classifications of Ramond-Ramond fields to list a few, and it is also an interesting application of the theory of infinity categories. I will try to give an audience-friendly overview of differential cohomology and a classification of higher line bundles (a. k. a. $U(1)$-banded gerbes) with connection. I will start from scratch and assume only some of basic differential geometry and algebraic topology so that it would be accessible to most of graduate students.

정 예 원 (KAIST) (월 20:00-20:50)

Moduli of Second Fundamental Forms of a Nonsingular Intersection of Two Quadrics

In 1979, Griffiths and Harris arised a question on the moduli of second fundamental forms of a projective complex submanifold of codimension two. We will report on our study of the question for complete intersections of two quadrics.

강 현 석 (GIST) (화,수 11:10-12:00)

Introduction to the eigenvalues of the Laplacian on Riemannian manifolds

We begin the lecture with the definitions and basic notion for the eigenvalues of the Laplacian on Riemannian manifolds. As examples, the eigenvalues of round spheres and tori are explicitly computed noting that there are only handful of cases in which the explicit spectrum is known. The second lecture will be focused on the bounds for the eigenvalues. Since the classical result was obtained by Li and Yau in 1983, various improvements and extension for the estimates of the first and the k-th eigenvalues have been made. We will review some of these results and also the gap between consecutive eigenvalues initiated from the work of Payne, Polya and Weinberger in 1955.

이 호 주 (서울대학교) (화 20:00-20:50, 수 09:00-09:50, 10:05-10:55)

Complex Analysis and Geometry of Soap Films

We give an introduction to some of important global results and interesting examples in the minimal surface theory. We provide several proofs of Bernstein's beautiful theorem that the only entire minimal graphs in Euclidean three-space are planes, and sketch various Bernstein type results in Euclidean four-space, which highlights the role of complex analysis in the modern theory of minimal surfaces.

Recommended Reading List:

- Joaquin Perez, **A new golden age of minimal surfaces**, Notices Amer. Math.Soc. 64 (2017), no. 4, 347-358. https://goo.gl/FeFtLf
- Jeremy Gray, Mario Micallef, **About the cover: the work of Jesse Douglas on minimal surfaces.** Bull. Amer. Math. Soc. (N.S.) 45 (2008), no. 2, 293-302. https://goo.gl/3NMs5M
- Minimal surface, https://en.wikipedia.org/wiki/Minimal_surface

박 진 형 (고등과학원) (수 20:00-20:50 목 9:00-9:50, 11:10-12:00)

Introduction to the Minimal Model Program

The principal aim of birational geometry is to classify algebraic varieties up to birational equivalence. It is equivalent to classifying function fields up to isomorphism. The first step for the birational classification of algebraic varieties would be to find a `nice' variety in each birational equivalence class. The minimal model program (MMP) was invented for this purpose. It turns out that MMP also provides many new powerful tools to solve a lot of important long standing conjectures in algebraic geometry. In these lectures, I explain basic notions and examples in birational geometry, and then, introduce main theorems and conjectures in the minimal model theory so that we will see how to run MMP. I also discuss some consequences of these theorems and conjectures.

김 현 규 **(이화 여자 대학교)** (목 19:00-19:50 20:00-20:50)

Quantum Geometry in 2d and 3d

푸아송(Poisson) 다양체의 변형 양자화(deformation quantization)란 다양체 위의 매끄러운(smooth) 함수들을 어떠한 규칙에 따라 힐베르트 공간 위의 작용소들로 변환하는 과정을 일컫는다. 이것은 먼저 매끄러운 함수들의 모임인 가환 환을 양자 버전의 비가환 환으로 변형한 뒤, 이 비가환 환의 힐베르트 공간 상의 표현(representation)을 건설하는 것으로 이해할 수도 있다. 특별히, 2차원 (실) 곡면 상의 복소구조 혹은 쌍곡계량(hyperbolic metric)들을 모아놓은 공간인 타이히뮐러 공간과 그 위의 Weil-Petersson 푸아송 구조에 대하여 변형 양자화를 건설하는 것이 양자 타이히뮐러 이론인데, 타이히뮐러 공간에는 곡면의 이산적 대칭군인 사상류군(mapping class group)이 작용하기 때문에, 결과적으로는 사상류군의 힐베르트 공간 상의 유니타리 표현을 얻는다. 본 강연에서는, 이에 관한 기초적인 내용과 연구 결과들을 소개하고, 2차원 및 3차원 기하학과의 연관성 등을 설명할 예정이다.

신 진 우 **(서강 대학교)** (금 9:00-9:50)

Three-dimensional m-quasi-Einstein manifolds with degenerate Ricci tensor

In this talk, we give a classification of three dimensional m-quasi Einstein manifolds with two distinct Ricci-eigen values. Our study provides explicit description of local and complete metrics and potential functions.

We also describe the associated warped product Einstein manifolds in detail. For the proof we present a Codazzi tensor on any three dimensional m-quasi Einstein manifold and use geometric properties of the tensor which help to analyze the m-quasi Einstein equation effectively.

김 준 태 **(서울 대학교)** (금 10:05-10:55)

Wrapped Floer Homology and Volume Growth of Symplectomorphisms

In this talk, we introduce wrapped Floer homology. Roughly speaking, this is a certain homology generated by intersection points of two Lagrangians and its differential is given by counting solutions to perturbed Cauchy-Riemann equation. We investigate an entropy-type invariant, called the slow volume growth, of certain symplectomorphisms and give a uniform lower bound of the growth using wrapped Floer homology. This is joint work with Myeonggi Kwon and Junyoung Lee.