計畫編號：BN01-00
計畫名稱：臺大數學科學中心
計畫主持人：林長壽
計畫摘要(中)：
本計劃旨在:
1. 促使數學科學研究中心成為一個卓越的研究中心，及提升臺灣數學的國際知名度。
2. 推動跨領域數學科學的研究。
3. 培育數學科學人才。
4. 提供海外學者返台和國內學者積極合作的平台。
5. 作為台大數學系與中研院數學所合作的平台。

這個計畫包含五個重要的研究主題：代數、代數幾何與數論，分析與幾何，計算與應用數學，離散數學與理論計算機科學，與複雜生物系統之統計及隨機分析。

計畫摘要(英)：
The objective of this plan is
1. Developing TIMS into a prestigious research institute and enhancing the international visibility (reputation) of Taiwanese mathematician
2. Fostering interdisciplinary research linking mathematics with important scientific and technological problems from other disciplines and industry.
3. Expanding and strengthening the talent base engaging in mathematical research.
4. Providing an environment to foster collaborative research between international and domestic scholars
5. Acting as a platform to broaden the cooperation between Math department of NTU and Mathematics Institute of Academia Sinica.

The project consist of five categories of major research fields: Algebra, Algebraic Geometry and Number Theory, Geometry and Analysis, Applied Mathematics and Computational Sciences, Discrete Mathematics and Theoretical Computer Sciences, Statistical and Stochastic Analysis for Complex Biological Systems.

計畫編號：BN01-01

計畫名稱：代數、代數幾何、與數論
計畫主持人：康明昌
計畫摘要(中)：
本計畫將集中在以下幾個主題：

- 代數幾何： 極小模型問題，動因上同調，算術幾何；
- 數論：Shimura 流形，Langlands 問題，橢圓曲線；
- 代數群：Galois 上同調，代數輪胎面，不變量與代數組合學，
- 表示論：李群與李代數，p 進階群，模表示。

這些主題都是目前數學研究最重要的問題，也是培育未來數學最主要的方向。

計畫摘要(英)：
In this project, we will focus on the following themes,

- Algebraic geometry: the minimal model program, motivic cohomology, arithmetic geometry;
- Number theory: Shimura varieties, Langlands program, elliptic curves;
- Algebraic group: Galois cohomology, algebraic tori, invariant theory and algebraic combinatorics;
- Representation theory: Lie theory, p-adic groups, modular representation theory.

All the P.I. and co- P.I.’s of this sub-projects either are experienced researches of these areas or will conduct mini-courses related to these areas. The long-termed goal of this sub-project is (i) to promote the research levels and to enhance the visibility of mathematicians of NTU and people in Taiwan among these areas, and (ii) to build up a strong school of algebraists, algebraic geometers and number theorists working on these areas.

計畫編號：BN01-02
計畫名稱：分析與幾何
計畫主持人：陳俊全
計畫摘要(中)：

在本計畫中,我們利用非線性分析的方法,來探討幾何與方程中,幾個非常重要的課題。這些主題兼具基礎性及整合性,與許多數學中

的不同領域相關聯,是我們發展領域整合的很好界面。計畫的第一部分是“分析與偏微分方程”，探討 Reaction-diffusion 方程、Liouville 型態方程、非線性薛丁格方程、Navier-Stokes 方程,以及逆問題中的核心題材。第二部分是“幾何分析”,研究幾何中兩個目前最重要的主題,一者是關於鏡對稱,另一者則是關於瑞奇流。

計畫摘要(英)：

Nonlinear phenomena appear abundantly and naturally in the world. Understanding these phenomena is of great importance and interests. In this subproject, we use nonlinear analysis to study several very important subjects in Geometry and Partial differential equations (PDE). The topics chosen share the common nature that is both fundamental and related to many different fields. They thus furnish a fertile meeting place to integrate the interests of researchers with different background and advance possible collaborations.

The first part of the subproject is “Analysis and PDE”, which aims on studying Reaction-diffusion Equations, Liouville Type Equations, Systems of nonlinear Schrondinger Equations, Navier-Stokes Equations, and Inverse problem. The second part of the subproject is “Geometric Analysis”, which includes two of the most important topics in the field. One is Ricci flow and related subjects. Another one concerns about Algebraic and Geometric structures from String Theory, mainly on Mirror Symmetry.

計畫編號：BN01-03
計畫名稱：計算與應用數學
計畫主持人：陳宜良
計畫摘要(中)：

在計算與應用數學子題裡，我們將探討與偏微分方程相關的建模、分析與計算問題。它包含下面五個課題

1. 微結構的宏觀行為---理論與計算：探討複合材料或周期性微奈米結構的力學、電學及光學的宏觀行為，我們將發展跨尺度的分析與計算方法。
2. 流體數值模擬的動力算則：處理稀薄氣體模擬的動力算則。
3. 界面問題：溶液中分子的電場及流體的動力界面問題。

4. 反問題，成像問題。
5. 大型距陣的特微值計算問題及其應用。

雖然這些課題有不同的應用，但許多數學的核心部分是共通的。這是應用數學研究的特色。

計畫摘要(英)：

In the subproposal of computational and applied mathematics, we shall focus on PDE (partial differential equations) related modeling, analysis and computations. It contains the following five subtopics:

1. Theory and computation of global behaviors of micro-structures: elastic, electric, optical or magnetic properties of composite material or material with periodic structure at nano scale will be studied; bridging-scale analysis and computation will be developed.
2. Kinetic schemes for fluid flow simulations: crossing-scale kinetic scheme for rarefied gas or shallow-water with zero height will be studied. The scheme can also be used for macroscopic hydrodynamic simulations. Particular application will be on typhoon study.
3. Interface problems—modeling and computation: electrostatic potential of macromolecule immersed in ion solution and capillary flows with surfactant will be investigated.
4. Inverse problems, imaging and image processing: we shall study electrical impedance tomography and image segmentation by PDE methods.
5. Eigenvalue computations for large scale matrices and their applications: software implementation, continuation methods and their application to Bose-Einstein condensation. Although these topics look differently from application point of view, they share many common mathematical core. This is the characteristic of this applied mathematics in an interdisplinary research team.

計畫編號：BN01-04
計畫名稱：離散數學與理論計算機科學
計畫主持人：張鎮華
計畫摘要(中)：

離散數學包含極多內容，本計畫的研究主題包含(但不局限於):

圖著色及其應用、圖分解及邊著色、圖形演算法及組合最優化、計算理論。

圖著色在離散數學中扮演中心角色，它主要在將一些事物分類，使得同類中不產生衝突。這樣的問題源自實用問題，例如: 排時、排序、頻道分配、資源分配等。我們研究的重點含: 圓著色、T 著色、距離二著色、邊著色、等分著色、分數著色、整數流等，我們亦超圖的著色。

許多組合結構、代數結構、及其他數學結構和圖的分解相關，造就了圖分解的重要性。另一方面，圖分解可應用到編碼學、實驗設計、X 光、密碼、電腦及通訊等。我們研究的重點含: 路徑分割、線性蔭度、線性 k 蔭度、點蔭度、樹蔭度、同位邊著色等。

圖是許多實務問題很好的模型，因此，用電腦程式幫忙解決圖上的問題，顯得特別重要。因此，圖論演算法成為一個重要的基礎工作。我們研究的重點含: 控制集問題及其變型、局部連通生成樹問題、保度生成樹問題等。

計算理論長久以來都被任為是計算機科學的核心，除了數學上的挑戰以外，計算理論也是計算機科學中不同課題的基礎。傳統計算理論中，P (BPP)含所有能用一般(機率)演算法有效解決的問題。並不驚奇的是，量子計算下 P 和 BPP 的計算，將有更深刻的結果。

計畫摘要(英)：

The subjects in discrete mathematics are various. The subjects studied in this proposal include, but not limited to, the following topics: graph coloring and its applications, graph decomposition and edge coloring, algorithmic aspects of graph theory and combinatorial optimization, theory of computation.

Graph coloring occupies a central position in discrete mathematics. Its archetypal problem is that of partitioning objects into classes to avoid conflicts within classes. Such problems arise in a wide variety of practical situations: scheduling, sequencing, frequency assignment, resource distribution … etc. The topics to be studied include circular chromatic number, T-coloring, distance-two coloring, edge coloring, equitable coloring, fractional chromatic number, integral flows … etc. Recent attempt is to work also on hyper-graph colorings.

Many combinatorial, algebraic, and other mathematical structures

are linked to graph decompositions, which gives theirs study a great theoretical importance. On the other hand, results on graph decompositions can be applied in coding theory, design of experiments, X-ray crystallography, radio astronomy, radiolocation, computer and communication networks, serology, and other fields. The topics to be studied in this line include path partition, linear arboricity, linear arboricity, linear k-arboricity, vertex arboricity, tree arboricity, and parity edge coloring.

As graphs serve as good models for many real word problems, it is important to be able to solve many graph problems by running computer programs. For this purpose, graph algorithm becomes an important foundation on this line. Among all graph algorithm problems, we are most concern on the domination problem and its variations, the locally connected spanning tree problem, the degree degree-preserving problem … etc.

Theory of Computation has long been recognized as the core of computer science. Aside from being extremely challenging from the mathematical viewpoint, the study of Theory of Computation also lays the foundations for a wide variety of disciplines in computer sciences. In classical complexity theory, P (respectively, BPP) constitutes the class for which problems can be solved efficiently deterministically (respectively, probabilistically). It is not surprising that when turning to the new computational paradigm, the quantum versions of P and BPP have attracted much attention in the community of complexity theory, and several deep results have been obtained for these two classes for classifying the relationships to their classical counterparts.

計畫編號：BN01-05
計畫名稱：複雜生物系統之統計及隨機分析
計畫主持人：陳宏
計畫摘要(中)：

系統生物學此領域之晚近發展，不但對生命科學產生革命性之改變，也對處理隨機現象之機率及統計此二領域之研究者提出挑戰，思考如何提供新的思維及方法，而加速此二領域之發展。在過去數年中，臺大之生、醫、農、電資相關系所已開始因應此一發展，但數學

及統計相關領域研究者，雖多在從事相關方法論之研究，但仍未能有一機制能正面呼應此發展。

本子計畫將借助本校合聘教授，中研院統計科學研究所李克昭特聘研究員，在本中心採每二週一整天之方式及每年二至三次之中小型主題式國際研討會，將臺大相關領域之研究者、研究生及進階大學生於中心集合進行學術研究及互動，預期能訓練新一代跨領域之研究者、促進跨領域研究、及研究課題能掌握現代科學發展潮流且具重大而持續之影響力、針對科學問題發展方法與理論。

計畫摘要(英)：

Recent development of system biology not only brings changes in life sciences but also challenges the researchers in probability and statistical sciences how to provide new methodology and scientific thinking which in turn expediting the development of both areas. In past few years, many changes have been made in various institutes in life sciences, medicine, public health, agriculture, information sciences, economics and management sciences at National Taiwan University. However, it lacks a mechanism to integrate the researchers in stochastic analysis with the researchers from other disciplines although the former already starts to work on theoretical research on the above area.

In this project, a mechanism will be built through the leadership of the joint appointed Professor, distinguished research fellow Dr. Ker-Chau Li at the Institute of Statistical Science, Academia Sinica to facilitate the integrated efforts of three research groups at Department of Mathematics, Department of Agronomy, and Graduate Institute of Epidemiology on providing solution to the challenge. A biweekly whole-day meeting and two to three theme topics yearly will be arranged in the center. Various researcher activities will be organized such that researchers, graduate students, and senior undergraduate students from various fields at NTU and Academia Sinica will be gathered. Through this project, it is expected that a new generation of researchers working on the inter-disciplinary will be nurtured and research teams will be fostered to deal with the emerging important researcher topics.