研究集会
「結び目のトポロジーIX」

トポロジー研究連絡会議の支援するトポロジープロジェクトの一環として、平成１８年度科学研究費補助金 (基盤研究（A)) 位相幾何学の総合的研究（課題番号 17204007） 研究代表者 日本大学理工学部 教授 松元重則の援助により、標記の研究集会を下記のように開催致します。

記

日時：平成１８年１２月１８日（月）～１２月２１日（木）
会場：日本大学文理学部百周年記念館
（周辺地図: http://www.chs.nihon-u.ac.jp/index-con/info_f.html）

プログラム

１２月１８日（月）

13:00-13:30 佐藤進（神戸大学理学部）
The sheet numbers of 2-knots with non-trivial quandles

曲面結び目の射影図は, 二重点曲線に沿って上下情報を入れることによって, 何枚かのコンパクト曲面に分割されている. この曲面をシートといい, すべての射影図にわたるその最小枚数を, 曲面結び目のシート数という（結び目の交点数の２次元版）. これまでの研究では, 曲面結び目のカンドル彩色やコサイクル不変量を用いてシート数の評価を与えてきた. 今回は, 球面結び目に限定すると, 非自明なカンドル（特に非自明な結び目群）をもつ球面結び目のシート数は常に４以上であることを示す.

13:30-14:00 岡本　美雪（日本工業大学工学部）
On the intrinsic virtual linkedness of complete bipartite graphs
(東京女子大学文理学部 小林一章氏との共同研究)

Intrinsic linking and knotting for virtul spatial graphs are introduced by T. Fleming and B. Mellor. They showed that the space of intrinsically linked graphs can be decomposed into an infinite sequence of nested spaces of graphs, which are virtually intrinsically linked of various degrees. In this talk, we consider the degree of $K_{m,4}$ with respect to the intrinsic virtual linkedness. Time permitting, we will also mention intrinsic virtual linking and knotting of K_7.

14:10-14:40 Zhang Gengyu（東京工業大学大学院理工学研究科）
Concordance crosscap number of a knot

We define the concordance crosscap number of a knot K as the minimum crosscap number among all the knots concordant to K. The four-dimensional crosscap number is the minimum first Betti number of non-orientable surfaces smoothly embedded in 4-dimensional ball, bounding K. Clearly the 4-dimensional crosscap number is smaller than or equal to the concordance crosscap number. We construct two infinite sequences of knots to explain the gap between the two.

14:40-15:10 栗屋　隆仁（九州大学大学院数理学府）
ＬＭＯ不変量とランダム行列モデルについて

有理ホモロジー 3 球面 M の量子 G 不変量において、M 上の可約な平坦接続に対応する部分の行列積分表示について説明し、特に自明な接続の寄与が LMO 不変量（を G で評価したもの）に対応することを説明する。$G = U(N)$ の場合は Garoufalidis と Marino による結果があり、今回は、一般の simply-laced 群、特に $G = SO(N)$ の場合についての得られた結果について話す予定である。

- Coffee Break -

15:30-16:00 鄭　仁大（大阪市立大学大学院理学研究科）
Alexander polynomials of special alternating links

We calculate the Alexander polynomial of a special alternating link by using a Seifert matrix. Using the matrix-tree theorem, we show that the Alexander polynomial is a sum of weighted monocycle states. As an application, we show that R.H.Fox's trapezoidal conjecture is true for special alternating genus 2 knots.

16:00-16:40 渡邉　忠之 (京都大学数理解析研究所)
Kontsevich's characteristic classes and some cocycles on the space of link embeddings

Konsevich constructed universal characteristic classes of vertically framed smooth bundles with fiber an odd dimensional homology sphere (Kontsevich classes) by using configuration space integrals. It has not been known whether the Kontsevich classes are non-trivial or not for dimensions ≥ 5. The cohomology of the space of higher-dimensional link embeddings is also not studied so much yet.
We will claim that the technique of 'suspension of surgery' can be used to prove the non-triviality of the Kontsevich classes or of configuration space integral classes on some spaces of link embeddings. We will observe for some bundles obtained by the suspension of higher-dimensional clasper surgeries that the characteristic numbers for the Kontsevich classes can be computed via some cocycles on the spaces of link embeddings.

16:50-17:30 長郷　文和（東京工業大学大学院理工学研究科）
Algebraic equations and knot invariants

I will talk about properties of the common zero set of some algebraic equations constructed by using a braid.

17:30-18:00 高田　敏恵（新潟大学・自然科学系）
Ohtsuki invariants for integral homology spheres and Habiro's cyclotomic expansion

We give a formula of the Ohtsuki invariants λ_1, λ_2 and λ_3 for integral homology spheres related to Habiro's cyclotomic expansion. As a application, we present some properties of λ_1, λ_2 and λ_3.

１２月１９日（火）

9:50-10:30 斎藤　敏夫（奈良女子大学大学院人間文化研究科）
Destabilizing Heegaard splittings of knot exteriors
(奈良女子大学 小林 毅氏との共同研究)

It is known that tunnel numbers of knots often go down under connected sum. Concrete examples are given by K. Morimoto (cf. Topology Appl. 64 (1995) 165–176). Let K_1 be a Morimoto knot given in the paper and K_2 a 2-bridge knot, and let T_i $(i = 1, 2)$ be minimal unknotting tunnel systems of K_i. Then $T_1 \cup T_2$ is an unknotting tunnel system of $K_1 \# K_2$ under appropriate connected sum. It is proved by Morimoto that $t(K_1 \# K_2) = 2 < t(K_1) + t(K_2) = 3$ and hence $T_1 \cup T_2$ is not minimal. In this talk, we give a necessary and sufficient condition for Heegaard splittings of knot exteriors to be stabilized. As an application, we show that a minimal genus Heegaard splitting of the exterior of $K_1 \# K_2$ above is obtained by destabilizing the Heegaard splitting of the exterior of $K_1 \# K_2$ with respect to $T_1 \cup T_2$.

10:40-11:10 岸本　健吾（大阪市立大学大学院理学研究科）
Braiding a link with a fixed closed braid

For every link with a sublink represented by a closed braid, we deform it into a closed braid by a deformation keeping the sublink fixed.

11:10-11:40 鈴木　亮平（東京大学数理科学研究科）
Khovanov homology and Rasmussen's s-invariants for pretzel knots

We calculated the rational Khovanov homology of some class of pretzel knots, by using the spectral sequence constructed by P. Turner. Moreover, we determined the Rasmussen's s-invariant of almost of pretzel knots with three pretzels.

11:50-12:20 伊藤　昇（早稲田大学大学院理工学研究科）
Invariants of plane curves and word theory

I would like to speak on some invariants of plane curves. V. Turaev introduces word theory, which is universal for knots, plane curves, etc. I apply word theory to reconstructing the basic invariants of V. I. Arnold and to getting some other invariants. I also express how these invariants classify plane curves.

12:20-12:50 堀内　澄子（東京女子大学大学院理学研究科）
On a ball in a metric space of knots by delta moves

By $\mathcal{K}$, we denote the set of all knots in S^3. For two knots K and K', we denote the minimum number of necessary times of delta moves for the sake of obtaining K' from K by $d_\Delta(K, K')$. Then $(\mathcal{K}, d_\Delta)$ is a metric space. Let n be an integer more than or equal to 0. And let k and ℓ be natural numbers with $1 \leq \ell < k$. We consider a ball $B_n^\Delta(K) = \{K' \in \mathcal{K} | d_\Delta(K, K') \leq n\}$. First, we show that for any knots K_1 and K_2 with $d_\Delta(K_1, K_2) = k$ (≥ 2), $B_\ell^\Delta(K_1) \cap B_{k-\ell}^\Delta(K_2)$ has infinitely many knots. And we consider the following question: If $B_n^\Delta(K_1) = B_n^\Delta(K_2)$, then are K_1 and K_2 the same knot type? We show some results for the question.

- Lunch Break -

13:50-14:20 大城　佳奈子（広島大学大学院理学研究科）

Good Involution と Quandle Homology Group について

good involution を持つ quandle による彩色と good involution 付き quandle homology group によって，classical link または surface link の不変量を定義できる．ここでは，有限 quandle に対する good involution と good involution 付きの quandle homololgy group を計算した結果を報告する．

14:20-15:00 門上　晃久（大阪市立大学数学研究所）

Figure eight knot と同じ Alexander polynomial を持つ knot に沿う Seifert surgery

Let K be a knot in an integral homology 3-sphere Σ. We denote a p/q-surgery along K by $\Sigma(K; p/q)$, where $p \geq 2$. By using the surgery formula for Reidemeister torsion, we obtain the following: **Main Theorem** *If the Alexander polynomial of K is $\Delta_K(t) = t^2 - 3t + 1$, then $\Sigma(K; p/q)$ $(p \geq 4)$ is not a Seifert fibered space over S^2.*

- Coffee Break -

15:20-15:50 寺垣内　政一（広島大学大学院教育学研究科）

A Seifert fibered manifold with infinitely many knot-surgery descriptions

Osoinach introduced a way to construct 3-manifolds obtained by the same integral Dehn surgery on an infinite number of knots in the 3-sphere. Using it, he gave such a hyperbolic 3-manifold and a toroidal manifold which is the union of two copies of the figure-eight knot exterior. In this talk, I will give the first example of a (non-Haken) Seifert fibered manifold that are obtained by the same integral surgery on an infinite number of hyperbolic knots. Interestingly, most of those knots have no symmetry. Thus those knots cannot lie on a genus two Heegaard surface of the 3-sphere. (Such knots are given by Deruelle-Miyazaki-Motegi as an application of their seiferter theory, but mine are different from them.)

15:50-16:20 Arnaud Deruelle（東京大学大学院数理科学研究科）

Networking Seifert fibered surgeries on knots II

(joint work with Katura Miyazaki and Kimihiko Motegi)

In our recent work, we introduced a *Seifert Surgery Network* using “seiferter” to get a global picture of Seifert surgeries. In this talk, we recall briefly the basics about such a Network and discuss its connectedness. For this purpose we extend the notion of seiferters by defining an “annular pair of seiferters”.

16:30-17:00 新庄　玲子 (大阪市立大学数学研究所)

An infinite sequence of non-conjugate braids

By the Classification Theorem of closed 3-braids given by J. Birman and W. Menasco, it is known that there are only finitely many mutually non-conjugate n-braids having the same closure for $n = 1, 2$ or 3. Therefore if there are infinitely many mutually non-conjugate n-braids having the same closure, then $n \geq 4$. H. Morton discovered an infinite sequence of non-conjugate 4-braids whose closures are equivalent to the unknot and constructed the first example of an irreducible presentation of the unknot. Then Fiedler combined both properties and showed the existence of an infinite sequence of irreducible conjugacy classes of 4-braids whose closures are the unknots. Later, using Fiedler's invariant, E. Fukunaga gave infinitely many conjugacy classes of 4-braids whose closures are the $(2, p)$-torus links ($p \geq 2$). In this talk, for some n-braids ($n \geq 4$) with a knot closure we give such infinite sequences of non-conjugate braids.

17:00-17:40 谷山　公規（早稲田大学教育学部）

Symmetries of spatial graphs and Simon invariants

(金沢大学教育学部 新國亮氏との共同研究)

An ordered and oriented 2-component link L in the 3-sphere is said to be *achiral* if L is ambient isotopic to its mirror image $L!$ ignoring the orientation and ordering of the components. Kirk-Livingston showed that if L is achiral then the linking number of L is not congruent to 2 modulo 4.
On the other hand, let K_5 and $K_{3,3}$ be a complete graph on five vertices and a complete bipartite graph on $3 + 3$ vertices respectively. For spatial embeddings of K_5 and $K_{3,3}$, the *Simon invariant* is defined, that is an odd integer valued invariant calculated from their regular diagrams, like the linking number. Simon invariants and linking numbers play a fundamental role in the homology classification of spatial graphs.
In this talk, with Kirk-Livingston's result above as an opportunity, we consider orientation preserving symmetries and orientation reversing symmetries of 2-component links, spatial embeddings of K_5 and spatial embeddings of $K_{3,3}$ induced by permutations on vertices, and completely determine the relationship between linking numbers, Simon invariants and their symmetries.

16:30-17:00 17:50-18:20 丹下 基生 (京都大学理学部)

ホモロジー３球面から得られるレンズ空間たちについて

We will show that many lens spaces can be constructed by positive Dehn suregeries of knots in the Poincaré homology sphere. The dual knots of such knots are all (1,1)-knots.

１２月２０日（水）

9:50-10:30 新國　亮（金沢大学教育学部）
グラフの極小化可能性と一般化された非自明射影について
(東京女子大学文理学部 小林一章氏との共同研究)

標準的空間グラフの候補として, グラフの 3 次元球面への**極小埋め込み**なる新たな空間表現を考えます. これを用いて, 平面的グラフの**自明化可能性**, 及び**非自明射影**の概念を非平面的グラフを含めた一般のグラフに階層的に拡張し, グラフの (n, k) **極小化可能性**, 及び**一般化された非自明射影**の概念を導入します. $(0, 0)$ 極小化可能性が従来の自明化可能性であり, また $(1, 1)$ 極小化可能性は平面性と一致します. 本講演では, 極小埋め込みの持つ基本的な性質を説明するとともに, $(1, k)$ 極小化可能性について最近調べてわかったことを報告します.

10:40-11:10 武田　康史（九州大学大学院数理学研究院）
Braid index and the number of Seifert circles for a virtual link

Kamada and Kauffman-Lambropoulou proved that any virtual link can be described as the closure of a virtual braid. Therefore, for a virtual link, we can define its virtual braid index as the minimal number of strings necessary for such a description. In classical link theory, Yamada showed that the minimal number of Seifert circles equals the braid index of a link. In this talk, we prove the analogy for virtual links, that is, that the minimal number of virtual Seifert circles equals the virtual braid index of a virtual link.

11:10-11:40 岩切　雅英 （広島大学大学院理学研究科）
The lower bound of the w-indices of surface links via quandle cocycle invariants

The minimal number of triple points of a surface braid S is called the *w-index of S*. The minimal number of the w-indices of surface braids whose closure is equivalent to a surface link F is called the w-index of F. S. Kamada proved that a surface link F is ribbon if and only if the w-index is zero. I. Hasegawa proved that the w-index of a non-ribbon surface link is at least 4 and the w-index of a non-ribbon spherical link is at least 6. M. Ochiai, T. Nagase and A. Shima proved that there is no surface link whose w-index is five.
In this talk, we will prove that there exsists a surface link F of any genus such that the w-index of F is 6. The result can be proved by using the quandle cocycle invariants defined by J. S. Carter, D. Jelsovsky, S. Kamada, L. Langford and M. Saito. Let Q be a quandle such that if $x * y = x$ for $x, y \in Q$, then $x = y$. In fact, it is proved more generally that if the cocycle invariants of a surface link F associated with Q is non-trivial, then the w-index of F is at least 6. The idea of the proof is based on S. Satoh and A. Shima's work of the lower bound of the triple point number of surface links given by using the cocycle invariants.

11:50-12:20 川越　謙一（金沢大学自然科学研究科）
On the limits of the HOMFLY polynomials

We consider the volume conjecture using the HOMFLY polynomials instead of the Jones polynomials. We obtain some examples such that the limit is different from the volume of knot.

12:20-12:50 境　圭一（東京大学大学院数理科学研究科）

Little disks action on the space of higher codimensional knots

We study the action of little disks operad on the space of (framed) long knots in $\mathbb{R}^n$, $n > 3$. On the homology of the space two Poisson algebra structures are defined in different ways. Our goal is that in fact these two structures coincide with each other. One way is topological: there exists an action at the space level (defined by D. Sinha, based on a work of J. McClure-J. Smith), and the action induces a natural Poisson bracket on the homology group, called the Browder operation. The other algebraic: we can compute the homology group by means of the spectral sequence constructed by A. Bousfield, whose E^2-term is so-called a Hochschild homology of certain operad. On such a homology the analogous Poisson structure was defined by M. Gerstenhaber-A. Voronov and V. Turchin. As a corollary, we can show that the (topological) Browder operation is not trivial when $n > 3$, which is an analogous result to that for $n = 3$, studied by R.Budney-F. Cohen.

- Lunch Break -

13:50-14:20 佐藤　好久（山口大学教育学部）

Minimality of genus-2 Lefschetz fibrations

４次元多様体 X から２次元多様体 Σ の上への可微分写像 $f : X \to \Sigma$ に対して、有限個の特異ファイバーを除いたところで曲面束の構造を持ち、各特異ファイバーが Lefschetz 型特異点である通常二重点を１つずつ持つような局所複素座標を導入することができるとき、写像 f を Lefschetz fibration という。例えば、任意の複素射影曲面 S は Lefschetz pencil と呼ばれる構造をもつ。これは、S を含む高次の複素射影空間 $\mathbb{C}P^N$ 内の余次元２超平面を軸とし $\mathbb{C}P^1$ にパラメータをもつ余次元１超平 面の族 $\{H_t\}_{t\in\mathbb{C}P^1}$ と S との交わりは、 S 上の曲線の pencil $\{H_t \cap S\}_{t\in\mathbb{C}P^1}$ を与える。これが Lefschetz pencil である。これの base locus で blow-up することで、Lefschetz fibration の構造を与えることができる。このように、Lefschetz fibration/pencil は複素代数幾何では自然に現れる概念である。この概念を可微分４次元多様体へ一般化したものが上記の定義であるが、シンプレクティックトポロジーとの深い関係が知られるようになって、現在では、４次元シンプレクティックトポロジーの中心的な研究対象の一つとなっている。複素射影曲面で見たように、非極小な Lefschetz fibration が自然に現れる。この講演では、種数２の Lefschetz 束空間の極小性について話そうと思う。一つは、ファイバー和の極小性に関する Stipsicz 予想の種数２の場合の肯定的解決について、もう一つは、非極小な種数２の Lefschetz 束空間の geography 問題についてである。これは、種数２のレフシェッツペンシルの Smith の有限性定理の拡張になっている。この講演は「結び目」とは関係ないが、Lefschetz fibration は３次元閉多様体の open book 分解を通して結び目と関連がある。

14:20-15:00 田中　利史（大阪市立大学大学院理学研究科）

On slice links in 4-manifolds

Let $\mathbf{M}$ be an oriented smooth 4-manifold. Let $\mathbf{B^4}$ be a unit 4-ball in $\mathbf{R^4}$ and L be a link in $\partial\mathbf{B^4} = \mathbf{S^3}$. L is called a *slice link* (or *topologically slice link*) if there exists a smooth embedding $\Phi : \mathbf{B^4} \to \mathbf{M}$ such that $\Phi : \mathbf{B}^4 \to \Phi(\mathbf{B}^4)$ is orientation preserving and L bounds a disjoint union of properly smoothly (or topologically flatly) embedded disks $(F, \partial F) \subset (M - \mathrm{Int}\Phi(\mathbf{B}^4), \Phi(\mathbf{S}^3))$. A link L is called an *exotic link* in M if L is a topologically slice link but not a slice link in M. It is well known that there are infinitely many exotic knots in $\mathbf{S}^4$ and by a result of A. Yasuhara, we know that there exist infinitely many exotic knots in $\mathbf{CP}^2$. On the other hand there is no exotic knot in $\mathbf{S^2} \times \mathbf{S^2}$ and $\mathbf{CP^2}\sharp\overline{\mathbf{CP^2}}$. Recently, we have shown that every noncompact, connected oriented smooth 4-manifold with an exotic link admits at least two smooth structures. So it seems to be meaningful to investigate exotic links in oriented smooth 4-manifolds. In this talk, we are restricted to $\mathbf{CP^2}$. By results of A. Casson, J. F. Davis, M. Freedman and A. Yasuhara, we show the following: (1) for any positive integer m, there exists an infinite family of m-component nonsplittable exotic links in $\mathbf{CP^2}$ such that they are not topologically slice links in $\mathbf{S}^4$; (2) every n-component link $(n = 1, 2)$ with trivial Alexander polynomial is a topologically slice link in $\mathbf{CP^2}$.

Question. Is there a non-slice knot with trivial Alexander polynomial in $\mathbf{CP^2}$?

Remark. If we would give an affirmative answer to the above question, then we could show that every noncompact, smooth submanifold of $\mathbf{CP^2}$ of dimension four admits at least two smooth structures.

- Coffee Break -

15:20-15:50 石井　敦（大阪大学大学院理学研究科）

The pole diagram and the virtual crossing number

A pole at a point of a strand in a surface is a unit normal vector to the strand at the point. A pole diagram is a (virtual) link diagram with poles. We put up poles at points of strands in a link diagram. Then we obtain a pole diagram. Using the notion, when a virtualized alternating link has certain property, we show that the virtual crossing number of the link is determined by its diagram or the maximal degree of its Miyazawa polynomial in t.

15:50-16:20 鎌田　直子（大阪市立大学数学研究所）

On twisted Miyazawa polynomials

Virtual links are abstracted from link diagrams on a surface. They are stable Reidemeister equivalence classes of link diagrams on closed oriented surfaces. On the other hand, Twisted links are abstracted from link diagrams on a surfaces, which are defined by M. Bourgoin. They are stable Reidemeister equivalence classes of link diagrams on closed surfaces. He extended Jones polynomials to twisted links, which are called twisted Jones polynomials. Miyazawa polynomials are invariants of virtual links, which are defined by Y. Miyazawa. In this talk, we discuss twisted Miyazawa polynomial invariants of twisted links.

16:30-17:00 Danielle O'Donnol（University of California, Los Angeles）
Intrinsically n-linked Complete Bipartite Graphs

A graph G, is *intrinsically linked* if every embedding of G into $\mathbb{R}^3$ contains a non-split link. The study of intrinsically knotted and linked graphs is a recent area of knot theory. I will give a brief summary of the history of intrinsically linked graphs and outline my proof that every embedding of the complete bipartite graph $K_{2n+1,2n+1}$ into $\mathbb{R}^3$ contains a non-split link of n-components. Time allowing, I will discuss some corollaries to this result.

17:00-17:40 下川　航也（埼玉大学大学院理工学研究科）
DNA and Lens space surgery

DNA の組み換え等の際の DNA のトポロジーの変化の研究において、strongly invertible knot の lens space surgery の研究が重要であることが知られている。この講演では、Dehn surgery の議論がどのように応用されているか、そして、生物学の観点からはどのような結果が求められているか等について講演する。

- 懇親会 -

１２月２１日（木）

9:50-10:30 安原　晃（東京学芸大学教育学部）
ストリング絡み目の C_n 分類とホモトピー分類

ストリング絡み目のホモトピー分類は，ミルナー不変量により与えられる事が知られている．このことは，絡み目のホモトピー分類に関する Habegger-Lin の論文の中で述べられているが，その証明は代数的である．ここでは，C_n 変形を用いる事により，幾何的な証明を与える．

10:40-11:10 小沢　誠（駒澤大学総合教育研究部自然科学部門）
Essential state surfaces for knots and links

We introduce a canonical spanning surface obtained from a knot or link diagram depending on a given state, and give a sufficient condition for the surface to be essential. Using the essential surface, we can see the triviality, splittability and primeness of a knot or link from its diagrams.

11:10-11:40 石川　昌治（東京工業大学大学院理工学研究科）
Legendrian graphs and quasipositive diagrams

In this talk, we clarify the relationship between ribbon surfaces of Legendrian graphs and quasipositive diagrams by using certain fence diagrams. As an application, we give an alternative proof of a theorem concerning a relationship between quasipositive fiber surfaces and contact structures on the 3-sphere.

11:50-12:20 Kenneth J. Shackleton（東京工業大学大学院情報理工学研究科）
On the distance between two Seifert surfaces for a knot

For a knot K in $\mathbf{S^3}$, Kakimizu introduced a simplicial complex whose vertices are all the isotopy classes of minimal genus spanning surfaces for K. We prove that the 1-skeleton of this complex has diameter bounded by a function quadratic in knot genus $g(K)$, whenever K is atoroidal. If, in addition, K is a genus 1 knot, the simple connectivity of Kakimizu's complex is proven.

12:20-12:50 市原　一裕（大阪産業大学教養部）

Exceptional surgeries on alternating knots

The well-known Hyperbolic Dehn surgery Theorem due to W.P. Thurston says that each hyperbolic knot admits only finitely many Dehn surgeries yielding non-hyperbolic manifolds. A lot of works have been done to study how many, when and on which knots such exceptional surgeries can occur. About the number of exceptional surgeries, it is conjectured by C. Gordon that they are at most 10, and the knot admitting 10 is only the figure-eight knot in the 3-sphere S^3.
In this talk, it will be shown that there are at most 10 exceptional surgeries on any hyperbolic alternating knot in S^3. We will actually show that all exceptional surgeries on such knots are integral. Then the main result follows from this together with the speaker's previous result.

世話人連絡先：　茂手木公彦 (motegi@math.chs.nihon-u.ac.jp)
〒１５６－８５５０ 東京都世田谷区桜上水３－２５－４０
日本大学文理学部数学教室
Tel: 03-3329-1151 ext. 5304