MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

Tagungsbericht 21/1987

Dynamische Systeme

10.5. bis 16.5.1987

Die Tagung fand unter der Leitung von Herrn J. Moser (ETH Zürich) und Herrn E. Zehnder (RWTH Aachen) statt. Die Teilnehmer kamen aus 13 Ländern, nämlich: Brasilien, Bundesrepublik Deutschland, England, Frankreich, Holland, Italien, Japan, Polen, Schweden, Schweiz, Spanien, UdSSR, USA.

Die Tagung brachte eine Fülle von neuen Ergebnissen und Forschungszielen und auch Beweise von langezeit offenen Vermutungen. Im Problemkreis der KAM-Theorie für Hamilton'sche Systeme und der Aubry-Mather-Theorie für monotone Twistabbildungen sind Fortschritte in theoretischer und praktischer Richtung erzielt worden. Im Hinblick auf Verallgemeinerungen der KAM-Theorie auf den unendlich dimensionalen Fall war die Teilnahme von Wissenschaftlern aus der mathematischen Physik besonders wichtig. Behandelt wurden zudem Themen aus den folgenden Gebieten: integrable Systeme, Ergodentheorie, Iteration von Abbildungen, Himmelsmechanik, Anosov-Systeme, globale Existenzprobleme mittels Variationsmethoden. Das Problem der strukturellen Stabilität wurde gelöst.

Vortragsauszüge

D.V. ANOSOV:

Flows on surfaces

Notations: M = closed surface of Euler characteristic < 0, $\tilde{M}$ = its universal covering, A = absolute, $\{\varphi_t\}$ = flow on M, $\{\tilde{\varphi}_t\}$ = its lift to $\tilde{M}$. The general idea is, that under rather general conditions (but not always) each semitrajectory $\tilde{L} = \{\tilde{\varphi}_t \tilde{z}; t \geq 0\}$ either remains bounded or tends to some point a of A (this a plays a role similar to the "rotation number"). In the latter case sometimes (but not always) $\tilde{L}$ remains at a bounded distance from the geodesic going to a. In exceptional cases $\tilde{L}$ can even have all points of A as its "limit points at infinity". Related questions concern the behaviour of lifts to $\tilde{M}$ of leaves of foliations on M or, more generally, nonselfintersecting infinite curves on M.

References: 1. S. Aranson, V. Grines. Soviet Math. Surveys, 1986, Vol. 1. 2. S. Aranson, V. Grines. In the book: Dynamical Systems, Vol. 1. Encyclopedia of Math. Sciences, Springer. 3. D. Anosov. Izvestia Acad. Sci. USSR (math.), 1987, Vol. 1. Other publications will appear in the same J. and in the "Proc. Steklov Math. Inst.", Vol. 185.

A. BAHRI:

Dynamics of gradient flows in the absence of the Palais-Smale condition

We show that in some variational problems having conformal invariance, the condition (C) of Palais and Smale has rather to be studied on flow-lines of the gradient equation. When this condition is violated on a flow-line, we introduce the concept of "critical point at infinity", which originates in some previous work in dynamical systems: "Pseudo-orbits of contact forms". We then derive existence results for scalar-curvature equations on S^3 and non linear problems of the type:

$$\Delta u + u^{\frac{n+2}{n-2}} = 0, \qquad u > 0 \text{ on } \Omega \subset \mathbb{R}^n$$
$$u = 0 \qquad \text{on } \partial\Omega$$

These techniques provide also a new proof of the Yamabe conjecture, (solved recently by R. Schoen), which does not make use of the positive mass theorem.

V. BANGERT:

Minimal laminations and commuting circle homeomorphisms

Let $F: \mathbb{R}^n \times \mathbb{R} \times \mathbb{R}^n \to \mathbb{R}$ be an integrand as considered by J. Moser (Ann. Inst. Poincaré - Analyse non linéaire (1986)): F is periodic in the first n + 1 variables, has positive definite second derivative with respect to the last n variables and satisfies certain natural growth conditions. A function $u: \mathbb{R}^n \to \mathbb{R}$ is (F-) minimal if $\int F(x,u,u_x)\,dx$ is minimal with respect to all compactly supported variations of u. We say that u has no selfintersections if the projection of graph (u) $\subset \mathbb{R}^{n+1}$ into the torus $\mathbb{R}^{n+1} / Z^{n+1}$ does not have proper selfintersections. Extending results by J. Moser we give a complete description of the set of all minimal solutions without selfintersections. Roughly it says the following: For every possible "type" of non selfintersecting graphs there exists a nonemty set of minimal solutions of this type unless the graphs of the minimal solutions of some "more periodic type" foliate $\mathbb{R}^{n+1}$. The graphs of the minimal solutions of the same "type" do not intersect and form a foliation or a lamination (≈foliation with gaps). This is a generalization of the Aubry-Mather theory to this higher dimensional setting.

G. BENETTIN:

Application of Nekhoroshev-like exponential estimates

Nekhoroshev-like exponential estimates are worked out for a class of Hamiltonian dynamical systems interesting for applications in physics. In the simplest case the Hamiltonian is $H = \omega I + h(p,q) + \omega^{-1} f(I,\varphi,p,q)$ with $(p,q) \in \mathbb{R}^{2n}$, and one wants to estimate the rate of the energy exchange between ωI and h, in the limit $\omega \to \infty$, but with a finite total energy. Two applications are suggested: (a) the introduction of a constraint in a dynamical system, by means of a device having a large elastic constant; (b) Jeans' problem (1903) of the collision of an atom with a vibrating molecule. The result is that the energy exchange per unit time is exponentially small in ω, so that: (a) the constrained system does not exchange appreciable amount of energy with the transversal vibrational motion for an exponentially long time; (b) an exponentially large number of collisions are needed, in order the vibrating molecule changes appreciably its internal energy. This means that, as conjectured by Jeans, there exists a completely classical mechanism for the so-called "freezing" of the high frequency degrees of freedom, which is usually considered to be a purely quantum effect.

O.I. BOGOYAVLENSKY:

On some constructions of integrable dynamical systems

A countable set of integrable dynamical systems, which tend to the Korteweg-de Vries equation in the continuous limit, is constructed. All these systems have a Lax representation and describe interactions between 2p + 1 neighbouring particles, where p is an arbitrary integer. For every set M with measure μ and a map $\alpha: M \to M$ preserving the measure μ, a construction of differential equations (in time t) in the space of measurable functions on M is pointed out. All equations constructed possess countably many first integrals.

M. CHAPERON:

An extension of the broken geodesics method to Hamiltonian systems

By a very easy trick, the use of functional analysis can be avoided in the proof of significant results in the calculus of variations in one variable. Examples are the Conley-Zehnder theorem (proof of the Arnol'd conjecture on the number of fixed points of symplectic maps of T^{2n}), Hofer's theorem on lagrangian intersections in cotangent bundles (as proven by Laudenbach and Sikorav) and Viterbo's theorem (Weinstein's conjecture in $\mathbb{R}^{2n}$) as proven by Hofer and Zehnder. We hope this list will not stop here.

A. CHENCINER:

Invariant punctured tori in the restricted 3-body problem

(Work with Jaume Llibre (Barcelóna)).

The Levi-Cività and McGehee regularization in the (planar circular) restricted 3-body problem allow us to prove the existence, for large negative values of the Jacobi constant, of invariant punctured tori in the phase space (diffeomorphic to an open solid torus) of the problem. When the collisions (ejections) are added, these tori become honest KAM tori.

L. CHIERCHIA:

Rigorous stability results for bidimensional KAM tori

Consider the Hamiltonian

$$\frac{1}{2} y^2 + \varepsilon(\cos x + \cos(x-t)) \;, \; y,x,t \in R,$$

with respect to the standard symplectic form $dy \wedge dx$. Numerical experiments suggest that the bidimensional KAM torus with rotation number $\frac{1+\sqrt{5}}{2}$ is smooth for $\varepsilon < \varepsilon_c = 0.034225$ but breaks down when $\varepsilon = \varepsilon_c$. We outline how, implementing a new KAM technique, one can give a rigorous (computer-assisted) proof of the stability and the smoothness of the above torus for complex values of ε with $|\varepsilon| < 0.034$.

J. DONNAY:

Ergodic Geodesic Flow on the Two-Sphere

A C^∞ metric is constructed on S^2 whose geodesic flow has positive measure entropy and is ergodic.
By the uniformization theorem, we can induce a metric of constant negative curvature on the sphere minus three points. Each deleted point gives rise to a cusp going to infinity, which we cut off at some finite point and replace in a smooth way with a cap made from a surface of revolution. The Clairaut Integral of motion allows explicit calculation of the geodesic motion on the surface of revolution. The cap is choosen so that a family of infinitesimally nearby geodesics that is diverging when entering the cap will focus once while in the cap and then again be diverging when leaving the cap. Using result's of Wojtkowski, we show that almost every point has a non-zero Lyapunov exponent. Positive entropy then follows by Pesin's formula.
This construction can be applied for surfaces of any genus yielding similar results.

H. ELIASSON:

Small Divisors and Siegel's Method

An idea behind a new proof of the existence of quasi-periodic solutions of a perturbation of an analytic (non-deg.) integrable Hamiltonian system is described. Such a system has a unique formal quasi-periodic solution for any fixed generic frequency.
The main difficulty in proving the convergence of the formal solution is that the "standard" series representation - The Lindstedt series - of this solution is not absolutely convergent. But the solution has another series representation which is absolutely convergent. This can in fact be proved by direct estimates of the coefficients using a generalization of Siegel's Method.

B. FIEDLER:

Global bifurcation of periodic solutions with symmetry

For differential equations with a compact symmetry group Γ some results on global Hopf bifurcation are presented. In particular it is investigated, how the spatial and temporal action of the group Γ on a periodic solution may vary along global bifurcation branches, e.g. at period doubling bifurcations. The results are obtained geometrically by generic but equivariant approximation, rather than by topological techniques. Applications to reaction diffusion systems are discussed.

J.P. FRANCOISE:

Period integrals in isochore and symplectic geometries

The path method of J. Moser is used to prove an isotopy theorem for the action-angles of integrable systems. The same theorem corresponds to an extension of a theorem of J. Vey on the isochore Morse lemma, when applied to volume forms instead of symplectic forms. Examples of calculations of actions are given: -The Calogero-Moser model: we prove a conjecture of Gallavotti and Marchioro, - The Neumann system, -The Kowalevskaya top.

J. FRÖHLICH:

Localization theory

Disordered (and quasi-periodic) crystal lattices are considered. In the harmonic approximation, it is shown that if the disorder or the frequency is large, lattice vibrations remain strictly localized, and there is no transport of energy through the crystal. Some extensions of these results to anharmonic crystal lattices are sketched: Using bifurcation techniques, localized periodic solutions to non-linear equations of motion for an infinite crystal lattice are constructed. In a simple example, an extension of the K.A.M. technique permits us to construct quasi-periodic vibrations supported by an infinite-dimensional, compact invariant torus. Other examples from condensed matter physics are described as well.

A. GIORGILLI:

Practical stability for Hamiltonian systems near equilibria

Consider an n-degrees of freedom Hamiltonian

$H = \frac{1}{2} \Sigma\, \omega_\ell (q_\ell^2 + p_\ell^2) + H_3 + \cdots$, where $\omega \in \mathbb{R}^n$ is irrational and $H_s, s \geq 3$, is a homogeneous polynomial of degree s. By performing Birkhoff normalizations up to a finite order r the Hamiltonian is transformed into $H^r = Z^r + \mathcal{R}^r$, where $Z^r = H_2 + Z_3 + \ldots + Z_r$ is in normal form, and $\mathcal{R}^r =$

$H^r_{r+1} + \ldots$ is the unnormalized remainder. Estimating this transformation leads to a lower bound $R^*_r \sim c/r^\tau$ ($c > 0$, $\tau > 1$), for the radius of a polydisk D_R where H^r is convergent, and where $|R^r| \lesssim d r^{\tau r} R^{r+1}$ for the size of the remainder. By looking for an optimal order r^* such that the remainder is minimized, one obtains the result that orbits starting in a polydisk D_S remain bounded in $D_{\sigma S}$, $\sigma > 1$, up to a time $T \approx \exp(K/(\sigma S))$, K being a constant. An application to the restricted three body problem gives a stability radius of some kilometres over a time interval of 10^{10} years, i.e. the estimated age of the universe.

G.R. HALL:

<u>Central Configurations in the 1+n body problem</u>

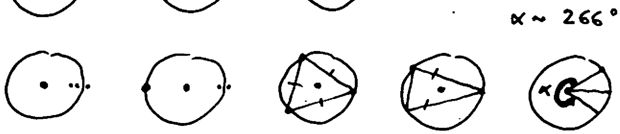
Let $q_0, \ldots, q_n \in \mathbb{R}^2$ be the limiting position of a family of central configurations (usual $\frac{1}{r}$ potential) for masses $m_0 = 1$, m, $= \ldots = m_n = \varepsilon \to 0$. Then (easily) we have

<u>Prop.1:</u> if $q_0 = 0^*$ (center of mass) and if $|q_1| = \ldots = |q_2|$, then we can obtain explicit solutions for

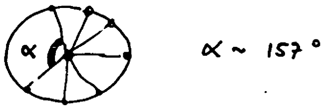
<u>1 + 1 bodies</u>

<u>1 + 2 bodies</u>

<u>1 + 3 bodies</u>



<u>1 + n bodies</u> always has regular n-gon solutions about 0^*. Simple numerial work indicates the possible existence of convex solutions for $n \leqslant 6$ and a solution for $n = 8$ of the form



<u>Prop.2:</u> For $n \geq 1$, the only 1 + n body central configuration with $q_i \neq q_j$ for $i \neq j$ is the regular n-gon. The value of n for the proof is $n > \exp[14 \cdot 16 \cdot (2\pi)^3]$.

M.R. HERMAN:

<u>Critical points on the boundaries of Siegel singular domains.</u>

We described the recent open questions on Siegel's linearization theorem for analytic maps of one complex variable (the center problem). We showed, according to E. Ghys (1983), the strong relation between the study of the boundary behaviour of Siegel's linearization map of an elliptic fixed point of a polynomial and the problem of global analytic conjugacy of diffeomorphisms of the circle to rotations. We announced the following theorem:

<u>Thm.:</u> There exists $\alpha \in \mathbb{R}-\mathbb{Q}$ such that $P_\alpha(z) = e^{2\pi i \alpha}(z + z^2)$ is linearizable at 0 and the Siegel singular disk S, $0 \in S$, is a quasi disk but the critical point $-\frac{1}{2}$ of P_α does not belong to the boundary of S.

(The Siegel singular disk S is the maximal connected open set S, $0 \in S$, such that $(P_\alpha^n | S)_{n \geq 0}$ is a normal family).

H. ITO:

<u>Integrability of Hamiltonian system near a non-resonant equilibrium and the convergence of the Birkhoff normal form</u>

We consider an analytic Hamiltonian system near an equilibrium point (1) $\dot{x}_k = H_{y_k}$, $\dot{y}_k = -H_{x_k}$, $H = H(x,y) =$

$H_2 + H_3 + \ldots$, $(k = 1,\ldots,n)$. It is wll known that if the characteristic exponents of the equilibrium are rationally independent (non-resonant), then there exists a formal canonical change of variables $(x,y) \rightarrow (\xi,\eta)$

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which takes the Hamiltonian into the Birkhoff normal form, i.e. into formal power series in $\xi_k \eta_k$ only. If this transformation is convergent, the system is integrable. We consider the converse problem and present the following result: THEOREM. Let the origin be a non-resonant equilibrium point of (1). Assume that there exist n analytic functionally independent integrals of (1) near the origin. Then there exists a convergent canonical change of variables which takes the Hamiltonian into the Birkhoff normal form. (It follows that the required integrals are in involution). This is a generalization of earlier results by H. Rüssmann and J. Vey.

A. KATOK:

Invariant cones and ergodicity

We establish verifiable criteria for ergodicity and for stronger stochastic properties, including Bernoulli proerty,for several classes of classical dynamical systems including symplectic diffeomophisms and contact flows on compact manifolds. The main ingredient is the existence of a continuous family of symplectic cones defined for all points of a sufficiently large open subset U of the phase space, which is mapped inside itself and eventually strictly inside itself by the linearization of the dynamical system induced on U. A result of Wojtkowski insures that the Lyapunov characteristic exponents are different from zero almost everywhere. Then, Pesin's theory can be applied to deduce that the ergodic components have positive measure. Our main technical advance is an observation, based upon a simple lemma about symplectic linear maps, whichallows us to extend almost every stable and unstable manifold to uniform size without too much wiggling. Then one can show that ergodic components are essentially open sets and with a little extra condition, which is easy to satisfy in most cases, that a single ergodic component encompasses the set U. In the case of flows the Bernoulli property follows from the non-integrability of the contact structure. These results allow us to unify and simplify the proofs for a number of previously known cases of ergodicity as well as to obtain some new ones. The primary new application is a construction of a C^∞ Riemannian metric with an ergodic and Bernoulli geodesic flow on every compact three-dimensional manifold.

P. LE CALVEZ:

Dynamical properties of monotone twist maps

J. Mather proved, using a variational method, that if f is an area - preserving monotone twist map of the annulus which has a region of instability, there is a point whose orbit goes from one border of the region to the other one. Using topological arguments, which go back to Birkhoff, we can get a simple proof of this fact. These topological techniques permit to give a more precise description of the dynamics of f inside the region of instability. They also permit to prove the following result: If we perturb our given map, the new one , which is not necessarily conservative, will still have a large interval of rotation numbers of Aubry-Mather sets.

J. MARTINET:

Algebraic differential equations in the plane have a finite number of limit cycles

Theorem: An analytic differential equation on an analytic, compact, real surface, has a finite number of limit cycles. A classical argument (Dulac) reduces this theorem to proving that the Poincaré first return mapping $G: (\mathbb{R}^+,0) \to (\mathbb{R}^+,0)$ of a polycycle (made up of hyperbolic or low dimensional systems (maps in dimension two and flows in dimension three): given two smooth topologically conjugate Anosov systems of this sort, a necessary and sufficient condition for the smoothness of the homeomorphism that conjugates one to the other is that corresponding periodic points have the same Lyapunov exponents. Nothing is known to us in the higher dimensional cases except in the special case of symplectic (canonical or Hamiltonian) systems, where there are partial results.

J. Palis:

Solution of the stability conjecture

A diffeomorphism is called C^r struturally stable if any C^r nearby diffeomorphism is conjugate to it via a homeomorphism of the ambient manifold. After a series of contributions (specially Anosov, and Palis-Smale), these last two authors conjectured in 1967 that " f is C^r stable iff $\Omega(f)$ is hyperbolic and for each pair of points in $\Omega(f)$ their stable and unstable manifolds meet transversally". Here $\Omega(f)$ stands for the nonwandering set of f. A similar conjecture, called Ω-stability conjecture, is: $f|\Omega(f)$ is C^r stable iff $\Omega(f)$ is hyperbolic and there are no cycles on $\Omega(f)$ ". The "if" parts of the conjectures were proven by Robbin-Robinson and Smale, respectively.
Theorem (Mañe) The C^1 stability conjecture is true.
Theorem (Palis) The Ω-stability conjecture is true.

J. POESCHEL:

An infinite dimensional K.A.M. theorem

Prompted by the work of J. Fröhlich, T. Spencer, a perturbation theory of KAM-type is presented, concerning certain weak couplings of harmonic oscillators on a lattice $\Lambda = Z^d$, $d \geq 1$. The system is described by the Hamiltonian

$$H = \sum_{i\in\Lambda} \omega_i I_i + \varepsilon \sum_{A\in B} P_A \ (I,\Phi),$$

where B is a system of finite subset of Λ, and P_A "lives on A". The frequencies ω_i are considered as parameters. Given a measure μ for subsets of Λ, e.g. (*) $\mu(A) = \sum_{i\in A} |i|$, it is shown that if $|P_A| \sim e^{-\mu(A)}$ (roughly speeking) then for suffient small ε the perturbed system possesses a large family of ∞-dim invariant tori. Their frequencies are strongly nonresonant in the sense that

$$|(k,\omega)| > \gamma \cdot \delta(|k|)\ \delta(\mu(\mathrm{supp}\ k))\ \forall k \in Z^{\Lambda} \setminus \{0\},$$

for $\delta(t) = e^{-t/\log^{1+\alpha} t}$, say. Of course, it has to be checked that this can be satisfied. For μ as in (*) this is the case.

D. SALAMON:

KAM theory in space configuration

(joint work with E. Zehnder). A new approach to KAM theory is presented adopting the Lagrangian rather than the Hamiltonian point of view. Let $F(x,\dot{x})$ be a Lagrangian which is periodic in the x-variables. An invariant torus for the Euler equations (1) $\frac{d}{dt} F_{\dot{x}} = F_x$ with frequency vector $\omega \in \mathbb{R}^n$ is given by a transformation $x = u(\xi)$ of T^n which satisfies (2) $E(u) := DF_{\dot{x}}(u,Du) - F_x(u,Du) = 0$ where $D = \Sigma\omega_r \partial/\partial\xi_r$. Equation (2) can be solved with the usual small divisor techniques provided that ω satisfies diophantine estimates, $F_{\dot{x}\dot{x}}$ is nondegenerate, F is sufficiently smooth and E (id) is sufficiently small. The proof is based on Newton's method and a key point is to overcome the degeneracy in the linear equation $E'(u)v = -E(u)$ which has to be solved approximately in each step of the iteration. This approach to KAM theory has been motivated by Moser's perturbation theorem for minimal foliations for variational problems on a torus.

C. SERIES:

Diophantine approximation and symbolic dynamics

A classical problem of diophantine approximation is to find for $x \in \mathbb{R}$, $c = c(x) = \inf \{c : |x - \frac{p}{q}| < \frac{c}{q^2}$ for infinitely many $q\}$. One has $c(x) \leq \frac{1}{\sqrt{5}}$ for all x. For certain special quadratic numbers, $c(x) \in (\frac{1}{3}, \frac{1}{\sqrt{5}}]$ and the possible values of $c(x)$ in this interval are discrete. This is called the Markoff spectrum. This problem can be interpreted as finding the distance of approach of geodesics to the cusp on a certain surface of constant negative curvature. Thus interpreted, it can be solved entirely by symbolic dynamics. This method suggests an extension to another surface, corresponding to approximation by $Q(\sqrt{5})$. The Markoff spectrum persists here.

E. WAYNE:

Periodic and quasi-periodic solutions of a nonlinear wave equation

Recently some progress has been made in understanding Hamiltonian systems with infinitely many degrees of freedom via classical mechanical perturbation theory. Systems with short range interactions, which often arise in condensed matter physics, were discussed in the talks of Fröhlich and Pöschel. Another class of systems one can consider from this point of view is the class of perturbations of completely integrable partial differential equations. Probably the simplest such equation is the non-linear wave equation,

$$\frac{\partial^2 u}{\partial t^2}(x,t) = \frac{\partial^2 u}{\partial x^2}(x,t) + p(x)u(x,t) + \varepsilon u^3(x,t) \; ; \; 0 \leq x \leq 1,$$

$$t \in \mathbb{R}, \; u(0,t) = u(1,t) = 0.$$

This equation can be rewritten as an infinite system of nonlinearly coupled, harmonic oscillators, which one then analyses using KAM theory. One can prove the existence of periodic solutions for a wide class of potentials $p(x)$ (and for more general nonliearities). It is hoped that these methods will also yield a proof of the existence of quasi-periodic solutions of this equation.

K. ZIEMIAN:

<u>Refinement of the Shannon-McMillan-Breimann theorem for some maps of an interval</u>

Let f be a piecewise monotone map of an interval I into itself, A the natural partition of I into the pieces of monotonicity of f, μ an f-invariant smooth probabilistic measure on I. Under some additional assumptions on f, like non-positive Schwarzian derivative, points are going far away from the set of critical points, all periodic points repelling and (f^k,μ) is weakly mixing for some iterate f^k. Let us assume (f,μ) is weakly mixing, and put $A_n = \bigvee_{i=0}^{n-1} f^{-i} A$. We prove the following: the sequence $\log(\mu(A_n(x))) + nh_\mu(f)$ satisfies the almost sure invariance principle for a large class of f satisfying the above assumptions. (for example f unimodal, except the fully chaotic one with $h_\mu(f) = \log 2$). Here $A_n(x)$ denotes the atom of A_n containing x. This theorem implies for example that the speed of convergence of $-\frac{1}{n}\log\mu(A_n(x))$ to $h_\mu(f)$ is not faster than $(\frac{\log\log n}{n})^{\frac{1}{2}}$.

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$\frac{1}{2}$-hyperbolic singular points and separatrices) is either the identity or has no fixed point close to 0 . This map G is the composition of local maps G_i corresponding to the singular points. At a hyperbolic saddle, G_i belongs to a quasi-analytic ring J (investigated by Ilyashenko). At a saddle-node, G_i is essentially the exponential of a resurgent function (Ecalle) $R_i \in R$; R is another quasi-analytic ring such that $J \cap R =$ {convergent series}. The theorem is proved by means of further quasi-analyticity and independance results. This proof is due to Ecalle, Martinet, Moussu, Ramis; a proof is also announced independantly by Ilyashenko.

J. MATHER:

Destruction of invariant curves

Consider an invariant closed curve of a C^∞ area preserving diffeomorphism of a surface. KAM theory guarantees that the curve persists for C^∞ perturbations provided the circle is C^∞ , its rotation number is Diophantine, and a twist condition is satisfied. I discussed a converse: provided a twist condition is satisfied and the rotation number is not Diophantine, the invariant curve can be destroyed by an arbitrarily C^∞ small perturbation, i.e. for a suitable such perturbation there is no invariant curve with the given rotation number. The key to the proof is a modulus of continuity for Peierls's barrier.

R. MORIYON:

Smooth conjugacy of Anosov systems

I described the results on smooth conjugacy of Anosov systems that have been proved up to now, and the technics involved. The situation is understood completely for

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Tagungsbericht 21/1987 **"Dynamische Systeme"** vom 10. - 16.5.1987

Leider fehlte eine Seite in dem o.g. Tagungsbericht. Wir bitten, dies zu entschuldigen und die beigefügte Seite 12a in den bereits an Sie gesandten Bericht einzufügen.

Meeting Report 21/1987 **"Dynamische Systeme"** from May 10 - 16, 1987

Unfortunately, one page of the above meeting report was missing. Please excuse this mistake and include the attached page 12a into the report which we had already mailed to you.