

## 微分可能な力学系の最近の話題

名大 教養部 白 岩 謙 一

§ 0 はじめに  $C^0$  級の微分可能な多様体上の微分可能な力学系について，構造安定性とそれに関する話題を紹介する。したがって多少古く結果が中心となるが，末尾に文献表をつけ，上記以外の話題，例えば，Morse-Smale の力学系，Anosov 力学系，測地流，Symbolic dynamics 及びエルゴード理論との関連分野，安定多様体の理論，ハミルトンの力学系，生成的な性質，分類問題，不変集合，分岐理論等，力学系の理論全体に関して新しいものを集めたので，総用して項ければ幸いである。勿論完璧を期したわけではなくて多くの脱落があるが，その責はお許し願いたい。

ここでは，簡単のため，コンパクトで境界を持たない  $C^0$  級多様体上の微分同相写像のなす離散力学系に関する結果を中心として記述し，境界をもつ場合，open manifolds の場合，ベクトル場による連続流の場合等については，判って

る限り文献を付けたので，これを参照して頂きたい．また，術語の説明は出来るだけ付けるようにしたが，場合によっては文献のみを示したので，これを参照して頂ければ幸いである．

§1 準備 以下特にことわらない限り，多様体は連結でコンパクトとして境界を持たない  $C^\infty$  級微分可能多様体とする．そして， $d$  をその距離とする，また， $r \geq 1$  とする．

$M$  を微分多様体とし， $\text{Diff}^r(M) = \{f: M \rightarrow M, C^r \text{ 級微分同相写像}\}$  に  $C^r$  位相を入れて位相空間にする．これは Baire 空間，さらに Banach 多様体になる．(Cf. Hirsch [4], Peixoto [4], Shiraiwa [1], Abraham [1])

定義 1  $f \in \text{Diff}^r(M)$  に対して， $x \in M$  が  $f$  の遊走点であるとは， $x$  の適当な近傍  $U$  に対して  $U \cap (\bigcup_{n=1}^{\infty} f^n(U)) = \emptyset$  が成立することである．遊走点でない点を非遊走点という．

$f$  の非遊走点全体の集合を  $\Omega(f)$  で表わし， $f$  の非遊走集合という．

$\Omega(f)$  は  $f$  不変 (i.e.  $f(\Omega(f)) = \Omega(f)$ ) な  $M$  の閉集合であって， $f$  の周期点全体の集合  $\text{Per}(f)$  を含む．

定義 2  $M, N$  を多様体とし， $f: M \rightarrow M, g: N \rightarrow N$  を微分同相写像とする．いま，適当な同相写像  $h: M \rightarrow N$  があって， $h \circ f = g \circ h$  が成立するとき， $f$  と  $g$  は位相的に同値 (または位相共役) といひ， $f \sim g$  で表わす．また，上の

$h$  を  $f$  と  $g$  の間の位相同値を与える同相写像とiii,  $h: f \sim g$  と表わす.

定義3  $f: M \rightarrow M, g: N \rightarrow N$  を定義2と同様とする. ii  
ま,  $\Omega(f)$  から  $\Omega(g)$  への適当な同相写像  $h: \Omega(f) \rightarrow \Omega(g)$   
があって,  $h \circ (f|_{\Omega(f)}) = (g|_{\Omega(g)}) \circ h$  が成立するとき,  
 $f$  と  $g$  は  $\Omega$ -同値 (または  $\Omega$ -共役) であるといii,  $f \sim g$   
と表わす.

定義4  $\varepsilon$  を正数とする. ii ま, 同相写像  $h: M \rightarrow M$  が  
 $d(x, h(x)) < \varepsilon, x \in M$  をみたすとき,  $h$  を  $\varepsilon$ -同相写像  
という.

定義5  $f: M \rightarrow M$  を  $C^r$  微分同相写像とする. 任意の正数  $\varepsilon$   
に対し,  $f$  の  $\text{Diff}^r(M)$  における適当な近傍  $N_\varepsilon$  があって,  $N_\varepsilon$   
に属する任意の  $g$  は  $f$  と位相的に同値で,  $f$  と  $g$  の間の位相  
同値を与える同相写像  $h: f \sim g$  が  $\varepsilon$ -同相写像にできるとき,  
 $f$  は強い意味で  $C^r$  構造安定という.

定義6  $f: M \rightarrow M$  を  $C^r$  微分同相写像とする. ii ま,  $f$  の  
 $\text{Diff}^r(M)$  における適当な近傍  $N$  があって,  $N$  に属する任意  
の  $g$  は  $f$  と位相的に同値となるとき,  $f$  を  $C^r$  構造安定という.

定義7  $f \in \text{Diff}^r(M)$  が  $\Omega$ -安定であるとは,  $f$  の  $\text{Diff}^r(M)$   
における適当な近傍  $N$  があって,  $N$  に属する任意の  $g$  は  $f$  と  
 $\Omega$ -同値となるときをいう.

多様体  $M$  の点  $p \in M$  における接ベクトル空間を  $T_p M$  とし,  
 $TM = \bigcup_{p \in M} T_p M$  を  $M$  の接ベクトル束の全空間とする. 微分同  
 相写像  $f: M \rightarrow M$  の点  $p$  における微分を  $T_p f: T_p M \rightarrow T_{f(p)} M$   
 とし,  $Tf: TM \rightarrow TM$  を  $T_p f, p \in M$  によって定義される  $f$   
 の微分とする.

定義 8  $\Lambda$  を  $f$  不変な  $M$  のコンパクト集合とし,  $T_\Lambda M =$   
 $\bigcup_{p \in \Lambda} T_p M$  とする. このとき, 次の条件 (a), (b) が成立する  
 なら,  $\Lambda$  を  $f$  の双曲型集合という.

(a)  $\Lambda$  の各点  $p$  に対して,  $T_p M$  の直和分解  $T_p M = E_p^s \oplus E_p^u$   
 が与えられ, この直和分解は  $p$  によって連続である. そして,

$$T_p f(E_p^s) = E_{f(p)}^s, \quad T_p f(E_p^u) = E_{f(p)}^u \quad \text{をみたす.}$$

すなわち,  $E^s = \bigcup_{p \in \Lambda} E_p^s, E^u = \bigcup_{p \in \Lambda} E_p^u$  とおくと, これは  
 $T_\Lambda M$  の  $Tf$ -不変な部分ベクトル束で,  $T_\Lambda M = E^s \oplus E^u$  と  
 Whitney 和に分解される.

(b)  $T_\Lambda M$  の適当な Finsler 構造  $\|\cdot\|$  (i.e.  $\|\cdot\|$  を  $T_p M$   
 上に制限したものは,  $T_p M$  のノルムで,  $\|\cdot\|$  は  $p \in \Lambda$  によ  
 って連続である) と, 定数  $c > 0, 0 < \lambda < 1$  があって, 任意  
 の整数  $n \geq 0$  に対して, 次の不等式が成立する.

$$\|Tf^n(v)\| \leq c\lambda^n \|v\|, \quad v \in E^s$$

$$\|Tf^{-n}(v)\| \leq c\lambda^n \|v\|, \quad v \in E^u$$

定義 9  $f: M \rightarrow M$  を微分同相写像とし,  $\varepsilon$  を正数とする.

いま,  $x \in M$  に対して,

$$W_\varepsilon^S(x) = \{y \in M; d(f^n(x), f^n(y)) < \varepsilon, n \geq 0\}$$

$$W_\varepsilon^u(x) = \{y \in M; d(f^{-n}(x), f^{-n}(y)) < \varepsilon, n \geq 0\}$$

をそれぞれ,  $x$  におけるサイズ  $\varepsilon$  の局所安定および局所不安定多様体という。また,

$$W^S(x) = \{y \in M; \lim_{n \rightarrow \infty} d(f^n(x), f^n(y)) = 0\}$$

$$W^u(x) = \{y \in M; \lim_{n \rightarrow \infty} d(f^{-n}(x), f^{-n}(y)) = 0\}$$

を  $x$  における安定および不安定多様体という。

安定多様体定理  $\Lambda$  は  $f$  の双曲型集合とし,  $T_x M = E_x^S \oplus E_x^u$  を定義  $\delta$  の分解とする。このとき, 次のことが成立する。

(a) 適当な連続写像  $\varphi: E^S \rightarrow M$  があって, 各点  $x \in \Lambda$  に対して,  $\varphi|_{E_x^S}: E_x^S \rightarrow M$  は  $C^r$  級 immersion となる。そして,  $\varphi(E_x^S) = W^S(x)$

(b)  $E_x^S$  の原点を中心とする半径  $\varepsilon > 0$  の開球を  $B^\varepsilon E_x^S$  とすると, 十分小さい  $\varepsilon$  に対して  $\varphi(B^\varepsilon E_x^S) = W_\varepsilon^S(x)$  が成立するよう  $\varphi$  をとることを加えられる。

(c)  $W^S(x)$ ,  $x \in \Lambda$  は点  $x$  で  $E_x^S \subset T_x M$  に接する。

(Cf. Hirsch-Pugh [1], Nitecki [4], Hirsch-Palis-Pugh-Shub [2])

この定理の拡張については, Kelley [1], Hirsch-Pugh-Shub [2] を参照するとよい。

## §2 Axiom A 微分同相写像

定義10  $f \in \text{Diff}^r(M)$  が次の条件を満たすとき, Axiom A 微分同相写像という.

Axiom A (a)  $\Omega(f)$  は双曲型である.

Axiom A (b)  $\text{Per}(f)$  は  $\Omega(f)$  で稠密である.

Smale のカオス系の理論で Axiom A を満たすカオス系は中心的役割りを果たす.

定義11  $\Omega(f)$  に対して, 次の条件が成立するとき,  $f$  はスペクトル分解をもつという.

(a)  $\Omega(f)$  は互いに交わりなし有限個の  $f$  不変な閉集合  $\Omega_1, \dots, \Omega_s$  の和集合である.

(b)  $f|_{\Omega_i} : \Omega_i \rightarrow \Omega_i$  ( $i=1, \dots, s$ ) は位相推移的である.  
(i.e. 適当な点  $x \in \Omega_i$  に対して,  $x$  の軌道  $\text{Orb}(x) = \{f^n(x); n \in \mathbb{Z} \text{ (整数)}\}$  は  $\Omega_i$  で稠密)

スペクトル分解定理 Axiom A 微分同相写像  $f$  はスペクトル分解  $\Omega(f) = \Omega_1 \cup \dots \cup \Omega_s$  をもつ. この分解は番号のつけ方を除いて一意的である.

(Cf. Smale [6], Pugh-Shub [2], Nitecki [4])

定義12 上のような  $\Omega_i$  を  $f$  の基底集合という.

定義13  $M$  の部分集合  $\Lambda$  に対して,

$$W^+(\Lambda) = \{y \in M; \lim_{n \rightarrow \infty} d(f^n(y), f^n(\Lambda)) = 0\}$$

$$W^-(\Lambda) = \{y \in M; \lim_{n \rightarrow \infty} d(f^{-n}(y), f^{-n}(\Lambda)) = 0\}$$

を  $\Lambda$  の in-set 及 out-set とする。また,

$$W^s(\Lambda) = \bigcup_{x \in \Lambda} W^s(x), \quad W^u(\Lambda) = \bigcup_{x \in \Lambda} W^u(x)$$

と置く。

定理 (In phase theorem)  $f$  を Axiom A 微分同相写像

とし,  $\Omega(f) = \Omega_1 \cup \dots \cup \Omega_s$  をそのスペクトル分解とすると,

$$W^+(\Omega_i) = W^s(\Omega_i), \quad W^-(\Omega_i) = W^u(\Omega_i), \quad i=1, \dots, s$$

が成立する。

(Cf. Hirsch-Palais-Pugh-Shub [1])

定理 Axiom A 微分同相写像  $f$  のスペクトル分解を  $\Omega(f) =$

$\Omega_1 \cup \dots \cup \Omega_s$  とすると,

$$M = \bigcup_{i=1}^s W^+(\Omega_i) = \bigcup_{i=1}^s W^-(\Omega_i)$$

と直和分割される。

(Cf. Smale [6], Nitecki [4])

Axiom A 微分同相写像  $f$  について, その基底集合  $\Omega_i$  上で  $f$  の位相構造を調べるために, 次の定理は基本的である。

定理 (Markov partition の存在)  $f$  を Axiom A 微分同相写像,  $\Omega(f) = \Omega_1 \cup \dots \cup \Omega_s$  をそのスペクトル分割とすると, 次のことが成立する,

(a)  $f|_{\Omega_i}: \Omega_i \rightarrow \Omega_i$  は Markov partition をもつ。

(b)  $f|_{\Omega_i}$  は finite type の subshift の quotient である。

ある。そして、この quotient map の各 fiber の位数は有界である。

(Cf. Bowen [1], [2], [6], [22])

また、この定理に関連して Kurata [1], [2] がある。

なお、この定理は Sinai [1] による Anosov 力学系の Markov partition の拡張である。

### §3 構造安定性

定義 14  $f$  を Axiom A 微分同相写像とする。いま、 $\Omega(f)$  の任意の 2 点  $x, y$  に対して、 $W^s(x)$  と  $W^u(y)$  が横断的に交わるとき、 $f$  は強横断性条件 (簡章のため S.T. と略記する) を満たすという。

定義 15 微分同相写像  $f: M \rightarrow M$  が次の 3 つの条件を満たすとき、これを Morse-Smale の力学系という。

- (a)  $\Omega(f)$  は有限集合である。(したがって  $\Omega(f) = \text{Per}(f)$ )
- (b)  $\Omega(f)$  は双曲型
- (c) S.T. を満たす。

上の定義から Morse-Smale の力学系は Axiom A と S.T. を満たす力学系であることがわかる。

定理 (a) Morse-Smale の力学系は構造安定である。

(b)  $M$  上の  $C^r$  級 Morse-Smale 力学系全体の集合  $MS^r(M)$  は  $\text{Diff}^r(M)$  の閉集合である。



(cf. Palis [2], Palis-Smale [1], Peixoto [2])

Morse-Smale の力学系  $f$  の位相的構造は多くの人によって調べられながら、次の論文は重要である。Smale [1], Shub-Sullivan [2]。

定義 16  $f: M \rightarrow M$  を微分同相写像とする。いま、 $M$  自身が  $f$  の双曲型集合となるとき、 $f$  を Anosov 力学系という。

定理 (Anosov の定理) (a) Anosov の力学系は構造安定である。

(b) Anosov 力学系は可算個の周期点をもち、

(c) Anosov 力学系は Axiom A と S.T. を満たす。

(d)  $M$  上の  $C^r$  級 Anosov 力学系全体の集合  $A^r(M)$  は  $\text{Diff}^r(M)$  の開集合である。

(cf. Anosov [1], [3], Moser [2], Franks [2], Shiraiwa [2])

Morse-Smale 力学系や Anosov 力学系以外にも構造安定な力学系がある。構造安定となるための条件として現在知られている最も良い定理は次のものである。

構造安定性定理  $f \in \text{Diff}^r(M)$  ( $r \geq 1$ ) が Axiom A と S.T. を満たすならば  $C^r$  構造安定である。

この種の定理として最初 Robbin [2] が  $C^2$  級微分同相写像が Axiom A と S.T. を満たすならば、強い意味で  $C^1$  構造安定と

なることを示した。上の形の定理は2次元多様体について、  
de Melo [1], 一般次元では Robinson [8] が示した。

流の場合には Andronov-Pontrjagin [1], Reixoto [2],  
Robinson [6], [7] がある。また、これらの他に Mendes  
[1], Percell [1] を参照された。

定義 17 Axiom A 微分同相写像  $f$  のスペクトル分解を  $\Omega(f) =$   
 $\Omega_1 \cup \dots \cup \Omega_s$  とする。いま、 $(W^u(\Omega_i) - \Omega_i) \cap (W^s(\Omega_j) - \Omega_j) \neq \emptyset$   
のとき、 $\Omega_j < \Omega_i$  と定義する。そして  $\Omega_{i_0} < \Omega_{i_1} < \dots < \Omega_{i_\ell}$ ,  
 $\ell \geq 1$ ,  $\Omega_{i_0} = \Omega_{i_\ell}$  と存在するような  $(\Omega_{i_0}, \Omega_{i_1}, \dots, \Omega_{i_\ell})$  を  $f$  の  
cycle とする。

$f$  に cycle が存在しないとき、no cycle とする。

$\Omega$ -安定性定理 微分同相写像  $f: M \rightarrow M$  が Axiom A と  
no cycle 条件を満たすならば、 $f$  は  $\Omega$ -安定である。

(Cf. Smale [7], Pugh-Shub [2], [4], 吉池 [1])

$\Omega$ -安定性の理論には filtration の概念が重要な役割を果たすが、  
ここでは省略する。詳細は次の論文を参照された。  
Smale [6], Shub-Smale: Beyond hyperbolicity,  
Ann. of Math., 96 (1972), 587-591, Shub [4], [6], Ni-  
tecki-Shub [1], 吉池 [1]。

#### §4 逆問題

構造安定性および  $\Omega$ -安定性定理の逆問題が未解決の重要

問題であるが、この逆問題に関する結果を述べよう。

定理  $\Omega(f)$  が有限集合なら、次の条件は同値である。

(a)  $f$  は構造安定

(b)  $f$  は Morse-Smale のカテゴリー

(c)  $f$  は Axiom A と S.T. を満たす。

(Cf. Palis-Smale [1], Palis [2], Peixoto [2])

定理  $\Omega(f)$  が有限集合なら

$f$  が  $\Omega$ -安定  $\iff f$  は Axiom A と no cycle 条件を満たす。

(Cf. Palis [3], Smale [7], Pugh-Shub [2], Smale [3], Kupka [1])

また、一般に次の定理がある。

定理  $f$  が Axiom A を満たすなら、

$\Omega$ -安定  $\iff$  no cycle

(Cf. Palis [3], [4])

定義18 微分同相写像  $f: M \rightarrow M$  が Kupka-Smale の条件を満たすとは、次の2つの条件が成り立つことである。

(a)  $f$  の周期点はいずれも双曲型

(b)  $f$  の任意の周期点  $x, y$  に対して、 $W^s(x)$  と  $W^u(y)$  は横断的に交わる。

Kupka-Smale の近似定理  $D: H^r(M)$  の中で Kupka-Smale の条件を満たす微分同相写像全体の集合  $KS^r(M)$  は

Baire 集合である, したがって稠密である.

(Cf. Kupka [1], Smale [3], Abraham-Robbin [1])

定理 (a) 構造安定な  $\Omega$  Kupka-Smale の条件を満たす.

(b)  $\Omega$ -安定な  $\Omega$ , 周期点すべて双曲型である.

(Cf. (a) は Robinson [4], (b) は Franks [3])

定理 次の4つの条件は同値である.

(a) Axiom A + S, T.

(b) absolutely structurally stable (Franks [5])

(c) time dependent stable (Franks [6])

(d) infinitesimally stable (Mañé [3])

定理 次の3つの条件は同値である.

(a) Axiom A + no cycle

(b) absolutely  $\Omega$ -stable (Guckenheimer [4], Franks [4], Gottlieb [1])

(c) chain recurrent set が双曲型 (Franke-Selgrade [2], [3])

また, Nitecki [3] による次の定理がある.

定理 (a) Axiom A + S, T  $\rightarrow$   $C^0$ -lower semi-stable

(b) Axiom A + no cycle  $\rightarrow$   $C^0$ -lower  $\Omega$ -semi-stable

さらに, Newhouse [3] による Axiom A であるための+

命条件を与える定理もある。

§5 稠密性と云うことは安定性等について  $M$  上の  $C^r$  構造安定な力学系全体の集合を  $SS^r(M)$ ,  $M$  上の  $C^r$  級  $\Omega$ -安定な力学系全体の集合を  $\Omega S^r(M)$  とおく。

定理 (a)  $\dim M = 1$ , 亦ち  $M = S^1$  (円周) のとき,  $SS^1(M)$  は  $\text{Diff}^1(M)$  の稠密な開集合である。

(b)  $\dim M \geq 2$  なる  $SS^1(M)$  は  $\text{Diff}^1(M)$  の中で稠密ではない。

(Cf. Peixoto [2], Smale [5], Newhouse [2], Williams [4], Peixoto-Pugh [1])

定理  $\Omega S^1(M)$  は  $\text{Diff}^1(M)$  の中で稠密とならないうような多様体  $M$  が存在する。

(Cf. Abraham-Smale [1], Simon [2])

定理  $SS^1(M)$  は  $\text{Diff}^1(M)$  の中で  $C^0$ -位相に関して稠密である。

(Cf. Shub [5], Shub-Sullivan [2], Smale [10], de Oliveira [1])

これらの他に安定性と稠密性について、次のような論述もある。

オ1積分について Arnaud [1], Peixoto [2], [3], Mañé [1]

'Axiom A(a)  $\rightarrow$  Axiom A(b)', について Newhouse-Palis [1], Pliss [1]

Tolerance stability  $12 \rightarrow 112$  Takeno [4], [10], White [1]  
 Stochastic stability  $12 \rightarrow 112$  Morimoto [1], [2], Sasaki [1]  
 Finite stability  $12 \rightarrow 112$  Robinson-Williams [1]  
 Future stability  $12 \rightarrow 112$  Shub-Williams [1]  
 Weak stability  $12 \rightarrow 112$  Ikegami [3]  
 Centralizer  $12 \rightarrow 112$  Anderson [1], Togawa [1], [2]

## Bibliography

## Symposium 記録

- [1] Symposium on differential equations and dynamical systems, Univ. of Warwick 1968-69, Lecture notes in math., No.206(1971), Springer  
(これを Warwick 1969 と略記する)
- [2] Proceedings of symposia in pure mathematics, Vol.14(1970), Global Analysis, Amer. Math. Soc.  
(これを Global Analysis と略記する。また, Amer. Math. Soc. を A.M.S. と略記する)
- [3] Dynamical systems (edited by M. Peixoto), Academic Press, 1973  
(これを Salvador 1971 と略記する)
- [4] Dynamical systems (edited by A. Manning), Lecture notes in math., No.468(1975), Springer  
(これを Warwick 1974 と略記する)
- [5] 力学系の総合的研究, 京都大学数理解析研究所講究録 No.173(1973)  
(これを講究録 No.173 と略記する) (以下同様)
- [6] 力学系の理論, i.b.i.d. No.216(1974)
- [7] 力学系の総合的研究, i.b.i.d. No.245(1975)
- [8] 電気回路の力学系, i.b.i.d. No.254(1975)
- [9] ———, i.b.i.d. No.284(1976)

## 論文及び著書

Abraham, R.

- [1] Lectures of Smale on differential topology, Mimeographed notes, Columbia Univ., 1962
- [2] Transversality in manifolds on mappings, Bull. A.M.S., 69(1963), 470-474

Abraham, R.-Marsden, J.

- [1] Foundations of mechanics, Benjamin, 1967

Abraham, R.-Robbin, J.

- [1] Transversal mappings and flows, Benjamin, 1967

Abraham, R.-Smale, S.

- [1] Non-genericity of  $\Omega$ -stability, Global Analysis, 5-8

Adler, R.L.-Konheim, A.G.-McAndrew, M.H.

- [1] Topological entropy, Trans. A.M.S., 114(1969), 309-319

Afraimovič, S.-Šilnikov, L.P.

- [1] Certain global bifurcations connected with the disappearance of a fixed point of saddle node type, Soviet Math. Dokl., 15(1974), 1761-1765

Alekseev, V.M.

- [1] Quasirandom dynamical systems, I, II, III, Math. Sbornik USSR, 5(1968), 73-128, 6(1968), 505-560, 7(1969), 1-43

Anderson, B.

- [1] Diffeomorphisms with discrete centralizer, Topology, 15(1976), 143-148

Andrea, S.A.

- [1] On homeomorphisms of the plane and their embedding in flows, Bull. A.M.S., 71(1965), 381-383

Andronov, A.-Pontrjagin, L.

- [1] Systèmes grossiers, Dokl. Akad. Nauk USSR, 14(1937), 247-251

Anosov, D.V.

- [1] Roughness of geodesic flows on compact Riemannian manifolds of negative curvature, Soviet Math. Dokl., 3(1962), 1068-1070  
 [2] Ergodic properties of geodesic flows on closed Riemannian manifolds of negative curvature, Soviet Math. Dokl., 4(1963), 1153-1156  
 [3] Geodesic flows on closed Riemannian manifolds with negative curvature, Proc. Steklov Inst. Math., 90(1967), 1-235  
 [4] Existence of smooth ergodic flows on smooth manifolds, Math. USSR Izv., 8(1974), 525-552

Anosov, D.V.-Katok, A.B.

- [1] New examples in smooth ergodic theory, ergodic diffeomorphisms, Trans. Moscow Math. Soc., 23(1970), 1-35

Anosov, D.V.-Sinai, Ja. G.

- [1] Certain smooth ergodic systems, Russian Math. Surveys, 22(1967), 103-167

Arnold, V.I.

- [1] Proof of a theorem of A.N. Kolmogorov on the invariance of quasi-periodic motions under small perturbations of the Hamiltonian, Russian Math. Surveys, 18, No.5(1963), 9-36  
 [2] Small denominators and stability of motion in classical and celestial mechanics, Russian Math. Surveys, 18, No.6(1963), 85-192  
 [3] Singularities of smooth mappings, Russian Math. Surveys, 23, No.1(1968), 1-43



- [4] Lectures on bifurcations in ~~X~~versal families, Russian Math. Surveys, 27, No.5(1972), 54-124
- [5] Critical points of smooth functions and their normal forms, Russian Math. Surveys, 30, No.5(1975), 1-75

Arnold, V.I.-Avez, A.

- [1] Problèmes ergodiques de la mécanique classique, Gauthier-Villars, 1966

Arraut, J.

- [1] Note on structural stability, Bull. A.M.S., 72(1966), 542-544

Arrowsmith, D.K.

- [1] Products of flows, Proc. Cambridge Philos. Soc., 73(1973), 301-306
- [2] The horseshoe and spinning diffeomorphisms, Proc. Cambridge Philos. Soc., 76(1974), 53-55

Artin, E.-Mazur, B.

- [1] On periodic points, Ann. of Math., 81(1965), 82-99

Asimov, D.

- [1] Round handles and non-singular Morse-Smale flows, Ann. of Math., 102 (1975), 41-54
- [2] Homotopy of non-singular vector fields to structurally stable ones, Ann. of Math., 102(1975), 55-65
- [3] Homotopy to divergence-free vector field, Topology, 15(1976), 349-352

Auslander, L.-Gottschalk, W.H.

- [1] Topological dynamics, An international symposium, Benjamin, 1968

Auslander, L.-Green, L.-Hahn, F. et al.

- [1] Flows on homogenous spaces, Princeton Univ. Press, 1963

Avez, A.

- [1] Ergodic theory of dynamical systems, I, II, Mimeographed notes, Univ. of Minesota, 1966, 1967

Banchoff, T.-Rosen, M.

- [1] Periodic points of Anosov diffeomorphisms, Global Analysis, 17-21

Bhatia, N.P.-Szegö, G.P.

- [1] Stability theory of dynamical systems, Springer (1970)

Birkhoff, G.D.

- [1] Dynamical systems, A.M.S., 1927

Block, L.

- [1] Non-continuity of topological entropy of maps of the Cantor set and the interval, Proc. A.M.S., 50(1975), 388-393

- [2] Morse-Smale endomorphisms of the circle, Proc. A.M.S., 48(1975), 457-463
  - [3] The periodic points of Morse-Smale endomorphisms of the circle, Trans. A.M.S., 226(1977), 77-88
- Block, L.-Franke, J.
- [1] A classification of the structurally stable contracting endomorphisms of  $S^1$ , Proc. A.M.S., 36(1972), 597-602
- Blohin, A.A.
- [1] Smooth ergodic flows on surfaces, Trans. Moscow Math. Soc., 27(1972), 117-134
- Boardman, J.M.
- [1] Singularities of differentiable maps, I.H.E.S. Math., 33(1967), 21-57
- Boltyanskii, V.G.
- [1] Homotopy of mappings and vector fields, A.M.S. Translation Series 2, 7(1957)
  - [2] Homotopy classification of vector fields, Dokl. Akad. Nauk USSR(1958), 731
- Bowen, R.
- [1] Markov partitions for Axiom A diffeomorphisms, Amer. J. Math., 92(1970), 725-747
  - [2] Markov partitions and minimal sets for Axiom A diffeomorphisms, Amer. J. Math., 92(1970), 907-918
  - [3] Topological entropy and Axiom A, Global Analysis, 23-42
  - [4] Periodic points, measures and Axiom A, Trans. A.M.S., 154(1971), 377-397
  - [5] Entropy for group endomorphisms and homogeneous spaces, Trans. A.M.S., 153(1971), 401-414
  - [6] One-dimensional hyperbolic sets for flows, J. Diff. Eq., 12(1972), 173-179
  - [7] Symbolic dynamics for hyperbolic flows, Amer. J. Math., 95(1973), 429-460
  - [8] Symbolic dynamics for hyperbolic systems, Lecture notes in math., No.318(1973), Springer, 51-58
  - [9] Entropy versus homology for certain diffeomorphisms, Topology, 13(1974), 61-67
  - [10] Maximizing entropy for a hyperbolic flow, Math. System Theory, 7(1974),

300-303

- [11]  $\omega$ -limit sets for Axiom A diffeomorphisms, J. Diff. Eq., 18(1975),

333-339

- [12] Equilibrium states and the ergodic theory of Anosov diffeomorphisms,  
Lecture notes in math., No.470(1975), Springer

- [13] A horseshoe with positive measure, Invent. Math., 29(1975), 203-204

- [14] Mixing Anosov flows, Topology, 15(1976), 77-80

Bowen, R.-Franks, J.

- [1] The periodic points of maps of the disk and the interval, Topology, 15  
(1976), 337-342

Bowen, R.-Lanford, O.E.

- [1] Zeta functions of restrictions of the shift transformation, Global  
Analysis, 43-50

Bowen, R.-Ruelle, D.

- [1] The ergodic theory of Axiom A flows, Invent. Math., 29(1975), 181-202

Brayton, R.-Moser, J.

- [1] A theory of nonlinear networks, I, II, Quart. Appl. Math., 22(1964),  
1-33, 81-104

Brin, M.I.

- [1] Topological transitivity of a certain class of dynamical systems and  
flows of frames on manifolds of negative curvature, Functional Analysis  
Appl., 9(1975), 8-16

- [2] A lower bound for the entropy of a smooth dynamical system, Functional  
Analysis Appl., 8(1974), 251-253

Brin, M.I.-Pesin, Ja. B.

- [1] Partially hyperbolic dynamical systems, Math. of USSR Izv., 8(1974),  
177-218

Brunovský, P.

- [1] On one parameter families of diffeomorphisms, Comment. Math. Univ.  
Carolinae, 11(1970), 559-582

- [2] Generic properties of the rotation number of one-parameter diffeomorph-  
isms of the circle, Czecho. Math. J., 24(99)(1974), 74-90

Buchner, M.A.

- [1] On the generic nature of property H1 for Hamiltonian vector fields,  
Global Analysis, 51-54

Byers, W.

- [1] Some properties of Anosov flows, *Canad. J. Math.*, 24(1972), 1114-1121

Camacho, C.

- [1] On  $\mathbb{R}^k \times \mathbb{R}^\ell$ -actions, Salvador 1971, 23-70
- [2] Morse-Smale  $\mathbb{R}^2$ -actions on two-manifolds, Salvador 1971, 71-74

Černyšev, V.E.

- [1] Structure of the invariant set of a diffeomorphism in the presence of a homoclinic points, *Vestnik Leningrad Univ.*, 1972, No.1, 70-76

Chewning, W.C.

- [1] A dynamical system on  $E^4$  neither isomorphic nor equivalent to a differential system, *Bull. A.M.S.*, 80(1974), 150-153

Chillingworth, D.

- [1] *Differential topology with a view to applications*, Pitman Publishing, 1976

Chow, S.N.-Halle, J.K.-Mallet-Paret, I.

- [1] Applications of generic bifurcations, *I. Arch. Rat. Mech. Anal.*, 59 (1975), 159-188

Churchill, R.

- [1] Isolated invariant sets in compact metric spaces, *J. Diff. Eq.*, 12 (1972), 330-350
- [2] Invariant sets which carry cohomology, *J. Diff. Eq.*, 13(1973), 523-550

Churchill, R.C.-Franke, J.-Selgrade, J.

- [1] A geometric criterion for hyperbolicity of flows, *Proc. A.M.S.*, 62 (1977), 137-143

Cotsaftis, M

- [1] Une propriété des orbites periodiques des systèmes hamiltoniens non linéaires, *C.R. Acad. Sci. Paris, Ser. A-B* 275(1972), A911-A914

de Blassi, F.S.-Schinas, J.

- [1] On the stable manifold theorem for discrete time dependent processes in Banach space, *Bull. London Math. Soc.*, 5(1973), 275-282

de Melo, W.

- [1] Structural stability of diffeomorphisms on two-manifold, *Invent. Math.*, 21(1973), 233-246
- [2] Stability and optimization of several functions, *Topology*, 15(1976), 1-12

de Melo, A.A.H.

- [1]  $\Sigma$ -gradient vector fields, J. Diff. Eq., 24(1977), 8-25

de Oliveira, M.M.C.

- [1]  $C^0$ -density of structurally stable vector fields, Bull. A.M.S., 82(1976), 786

Devaney, R.

- [1] Homoclinic orbits in Hamiltonian systems, J. Diff. Eq., 21(1976), 431-438

- [2] Reversible diffeomorphisms and flows, Trans. A.M.S., 218(1976), 89-113

Dobrynskiĭ-Šarkovskiĭ

- [1] Genericity of the dynamical systems almost all of whose trajectories are stable under constantly acting perturbations, Soviet Math. Dokl., 14(1973), 997-1000

Easton, R.W.

- [1] Locating invariant sets, Global Analysis, 55-59
- [2] Isolating blocks and symbolic dynamics, J. Diff. Eq., 17(1975), 96-118

Eberlein, P.

- [1] When is a geodesic flow of Anosov type?, I, II, J. Diff. Geometry, 8(1972), 437-463, 565-577
- [2] Geodesic flow in certain manifolds without conjugate points, Trans. A.M.S., 167(1972), 151-170
- [3] Geodesic flows on negatively curved manifolds, I, II, Ann. of Math., 95(1972), 492-510, Trans. A.M.S., 178(1973), 57-82

Ebin, D.G.

- [1] Completeness of Hamiltonian vector fields, Proc. A.M.S., 26(1970), 632-634

Ellis, R.

- [1] The construction of minimal discrete flows, Amer. J. Math., 87(1965), 564-574

El'sgol'c, L.È.

- [1] Qualitative methods in mathematical analysis, Transl. of Math. Monographs, 12(1964), A.M.S.

England, J.W.-Smith, R.L.

- [1] The zeta function of automorphisms of solenoid groups, J. Math. Anal. Appl., 39(1972), 112-121

Epstein, D.B.A.

- [1] Periodic flows on three-manifolds, Ann. of Math., 95(1972), 66-81

Epstein, D.B.A.-Shub, M.

[1] Expanding endomorphisms of flat manifolds, *Topology*, 7(1968), 139-141  
Fenichel, N.

[1] Persistence and smoothness of invariant manifolds for flows, *Indiana Univ. Math. J.*, 21(1971), 193-226

[2] Exponential rate conditions for dynamical systems, *Salvador 1971*, 91-94

[3] Asymptotic stability with rate conditions for dynamical systems, *Bull. A.M.S.*, 80(1974), 346-349

[4] The orbit structure of the Hopf bifurcation problem, *J. Diff. Eq.*, 17(1975), 308-328

Field, M.

[1] Equivariant dynamical systems, *Bull. A.M.S.*, 76(1970), 1314-1318

Fleitas, G.

[1] On the classification of flows and manifolds, *Mimeographed note*

Franke, J.

[1] Structural stability of smooth contracting endomorphisms on compact manifolds, *Astérisque Société Math. France*, 31(1976), 141-188

Franke, J.-Selgrade, J.

[1] Abstract  $\omega$ -limit sets, chain recurrent sets, and basic sets for flows, *Proc. A.M.S.*, 60(1976), 309-316

[2] Hyperbolicity and chain recurrence, *Mimeographed note*

[3] Equivalent criteria for Axiom A and no cycles, *Mimeographed note*

Franks, J.

[1] Anosov diffeomorphisms on tori, *Trans. A.M.S.*, 145(1969), 117-124

[2] Anosov diffeomorphisms, *Global Analysis*, 61-94

[3] Necessary conditions for stability of diffeomorphisms, *Trans. A.M.S.*, 158(1971), 301-308

[4] Differentiably  $\Omega$ -stable diffeomorphism, *Topology*, 11(1972), 107-114

[5] Absolutely structurally stable diffeomorphisms, *Proc. A.M.S.*, 37(1973), 293-296

[6] Time dependent stable diffeomorphisms, *Invent. Math.*, 24(1974), 163-172

[7] Morse inequalities for zeta functions, *Ann. of Math.*, 102(1975), 143-157

[8] Constructing structurally stable diffeomorphisms, *Ann. of Math.*, 105 (1977), 343-360

[9] Some smooth maps with infinitely many hyperbolic periodic points, *Trans. A.M.S.*, 226(1977), 175-179

Franks, J.-Robinson, C.

[1] A quasi-Anosov diffeomorphisms that is not Anosov, Mimeographed note  
Fuller, F.B.

[1] An index of fixed point type for periodic orbits, Amer. J. Math., 89  
(1967), 133-148

[2] Bounds for the periods of periodic orbits, Topological dynamics.  
(Sympos. Colorado State Univ. (1967)), Benjamin 1968, 205-215

Gibbons, J.C.

[1] One dimensional basic sets in the three-sphere, Trans. A.M.S., 164  
(1972), 163-178

Giffen, C.H.

[1] Diffeotopically trivial periodic diffeomorphisms, Invent. Math., 11  
(1970), 340-348

Glasner, S.

[1] Compressibility properties in topological dynamics, Amer. J. Math.,  
97(1975), 148-171

Godbillon, C.

[1] Géométrie différentiable et mécanique analytique, Hermann 1969

Goodman, T.N.T.

[1] Relating topological entropy and measure entropy, Bull. London Math.  
Soc., 3(1971), 176-180

Goodwyn, W.

[1] Topological entropy bounds measure-theoretic entropy, Proc. A.M.S.,  
23(1969), 679-688

[2] The product theorem for topological entropy, Trans. A.M.S., 158(1971),  
445-452

[3] Comparing topological entropy with measure-theoretic entropy,  
Amer. J. Math., 94(1972), 366-388

Gordon, W.B.

[1] A theorem on the existence of periodic solutions to Hamiltonian systems  
with convex potentials, J. Diff. Eq., 10(1971), 324-335

[2] Conservative dynamical systems involving strong forces, Trans. A.M.S.,  
204(1975), 113-135

Gottlieb, A.

[1] Converses to the  $\Omega$ -stability and invariant lamination theorems, Trans.  
A.M.S., 202(1975), 369-383

Gottschalk, W.H.

- [1] Minimal sets, An introduction to topological dynamics, Bull. A.M.S., 64(1958), 336-351

Gottschalk, W.H.-Hedlund, G.A.

- [1] Topological dynamics, A.M.S., 1955

Graff, S.M.

- [1] On the conservation of hyperbolic invariant tori for Hamiltonian systems, J. Diff. Eq., 15(1974), 1-69

Green, L.W.

- [1] The generalized geodesic flow, Duke Math. J., 41(1974), 115-126

Grobman, D.M.

- [1] Homeomorphisms of systems of differential equations, Dokl. Akad. Nauk., 128(1959), 880-881

Guckenheimer, J.

- [1] Endomorphisms of the Riemann sphere, Global Analysis, 95-124
- [2] Axiom A + no cycle  $\Rightarrow \zeta_f(t)$  rational, Bull. A.M.S., 76(1970), 592-595
- [3] Bifurcation and catastrophe, Salvador 1971, 95-109
- [4] Absolutely  $\Omega$ -stable diffeomorphisms, Topology, 11(1972), 195-198
- [5] Hartman's theorem for complex flows in the Poincaré domain, Compositio Math., 24(1972), 75-82
- [6] One-parameter families of vector fields on two-manifolds, Salvador 1971, 111-127
- [7] Caustics and non-degenerate Hamiltonians, Topology, 13(1974), 127-133
- [8] Solving a single conservative flow, Warwick 1974, 108-134

Guinez, J.

- [1] Entropie topologique et rayon de convergence de la fonction zêta des endomorphismes dilatants de variétés compacts, C.R. Acad. Sci., Paris, Sér. A-B 270(1970), A1408-A1411

Gurevič, B.M.

- [1] The invariant measure with maximal entropy for an Anosov diffeomorphism, Functional Analysis Appl., 4(1970), 282-289

Hale, J.K.-Rodrigues, H.M.

- [1] Bifurcation in the Duffing equation with independent parameters, I, II, Mimeographed note

Harrison, J.

- [1] Unsmoothable diffeomorphisms, Ann. of Math., 102(1975), 85-94



Hartman, P.

- [1] The stable manifold of a point of a hyperbolic map of a Banach space, J. Diff. Eq., 9(1971), 360-379

Hartzman, C.S.

- [1] Denjoy-type flows on orientable 2-manifolds of higher genus, Trans. A.M.S., 186(1973), 219-227

Hedlund, G.

- [1] The dynamics of geodesic flows, Bull. A.M.S., 45(1939), 241-246

Hirsch, M.W.

- [1] On invariant subsets of hyperbolic sets, Essays on topology and related topics, Springer, 1970, 121-135
- [2] Expanding maps and transformation groups, Global Analysis, 125-132
- [3] Anosov maps, polycyclic groups and homology, Topology, 10(1971), 177-184
- [4] Differential topology, Springer 1976

Hirsch, M.W.-Palis, J.-Pugh, C.-Schub, M.

- [1] Neighborhoods of hyperbolic sets, Invent. Math., 9(1970), 121-134

Hirsch, M.-Pugh, C.

- [1] Stable manifolds and hyperbolic sets, Global Analysis, 133-165

Hirsch, M.-Pugh, C.-Shub, M.

- [1] Invariant manifolds, Bull. A.M.S., 76(1970), 1015-1019
- [2] Invariant manifolds, Lecture notes in math., No.583(1977), Springer

Hopf, E.

- [1] Statistik der geodötischen Linien in Mannigfaltigkeiten negativer Krümmung, Ber. Verh. Sächs. Akad. Wiss. Leipzig, 91(1939), 261-304
- [2] Abzweigung einer Periodischen Lösung eines Differential Systems, Ber. Verh. Sächs. Akad. Wiss. Leipzig Math. Phys., 95(1943), 3-22
- [3] Ergodic theory and the geodesic flow on surfaces of constant negative curvature, Bull. A.M.S., 77(1971), 863-877

Humphries, P.D.

- [1] Change of velocity in dynamical systems, J. London Math. Soc., 7(1974), 747-757

Hurley, D.

- [1] Topological entropy of the geodesic flows on manifolds of hyperbolic type, J. London Math. Soc., 12(1976), 149-159

Ichiraku, S.

- [1] On the transitivity conditions in electrical circuits, 電気回路 1976

Ihrig, E.

- [1] The regularization of nonlinear electrical circuits, Proc. A.M.S. 47(1975), 179-183

Ikegami, G.

- [1] On classification of dynamical systems with cross-sections, Osaka J. Math., 6(1969), 419-433  
 [2] Flow equivalence of diffeomorphisms I, II, Osaka J. Math., 8(1971), 49-69, 71-76  
 [3] On weak concept of stability, Nagoya Math. J., 55(1974), 161-179

Irwin, C.

- [1] A classification of elementary cycles, Topology, 9(1970), 35-47  
 [2] On the stable manifold theorem, Bull. London Math. Soc., 2(1970), 196-198  
 [3] On the smoothness of the composition map, Quart. J. Math., Oxford (2), 23(1972), 113-133  
 [4] Hyperbolic time-dependent processes, Bull. London Math. Soc., 5(1973), 209-217  
 [5] A stability characterization of Anosov diffeomorphisms, Proc. London Math. Soc., 34(1977), 479-504

Kaplan, W.

- [1] Regular curve families filling the plane, I, II, Duke Math. J., 7(1940), 154-185, 8(1941), 11-46

Kato, J.-Morimoto, A.

- [1] Topological stability of Anosov flows and their centralizers, Topology, 12(1973), 255-273

Katok, A.b.

- [1] Ergodic perturbations of degenerate integrable Hamiltonian systems, Math. of USSR Izv., 7(1973), 535-572

Kawakami, H. (川上 博)

- [1] Sur les points fixes des itérés d'un diffeomorphisme dans le voisinage d'un point homcline, J. Diff. Eq., 14(1973), 442-461  
 [2] ある電気回路の力学系, Mimeographed note (1974)

Kelley, A.

- [1] The stable, center-stable, center, center-unstable and unstable manifolds, Appendix C. in Abraham-Robbin: Transversal mappings and flows

Keynes, H.B.-Robertson, J.B.

- [1] Generators for topological entropy and expansiveness, Math. System Theory, 3(1969), 51-59

Klingenberg, W.

- [1] Geodätischen Fluß auf Mannigfaltigkeiten von hyperbolischen Typ, Invent. Math., 14(1971), 63-82  
 [2] Riemannian manifolds with geodesic flow of Anosov type, Ann. of Math., 99(1974), 1-13

Klingenberg, W.-Takens, F.

- [1] Generic properties of geodesic flows, Math. Ann., 197(1972), 323-334

Kneser, H.

- [1] Reguläre Kurvenscharen auf den Ringflächen, Math. Ann., 91(1924), 135-154

古池時日児

- [1] Differentiable dynamical systems on noncompact manifolds, 講究録 No.284, 96-112

Kopell, N.

- [1] Commuting diffeomorphisms of the circle, Global Analysis, 165-184

Kramli, A.

- [1] Geodesic flows on compact Riemannian surfaces without focal points, Studia Sci. Math. Hungar., 8(1973), 59-78

Kryloff, N.-Bogoliouboff, N.

- [1] La théorie générale de la mesure dans son application à l'étude des systèmes dynamiques de la mécanique non linéaire, Ann. of Math., 38 (1937), 65-113

Krzyzewski, K.-Szlenk, W.

- [1] On invariant measure for expanding differentiable mappings, Studia Math., 33(1969), 83-92

Kuiper, N.H.

- [1] The topology of the solutions of a linear differential equation on  $\mathbb{R}^n$ , Manifolds-Tokyo 1973, Univ. of Tokyo Press, 195-204  
 [2] Topological conjugacy of real projective transformations, Topology,

15(1976), 13-22

Kuiper, N.H.-Robbin, J.

- [1] Topological classification of linear endomorphisms, *Invent. Math.*, 19 (1973), 83-106

Kupka, I.

- [1] Contribution à la théorie des champ génériques, *Contributions to differential equations*, 2(1963), 457-484, 3(1964), 411-420
- [2] On two notions of structural stability, *J. Diff. Geo.*, 9(1974), 639-644

Kurata, M.

- [1] Hartman's theorem for hyperbolic sets, *Nagoya Math. J.*, 67(1977)
- [2] Markov partitions of hyperbolic sets, Mimeographed note

Kurzweil, J.

- [1] Invariant manifolds I, *Comment. Math. Univ. Carolinae*, 11(1970), 309-336

Kyner, W.T.

- [1] Invariant manifolds, *Rend. Circ. Math. Palermo. (ser.2)* 10(1961), 98-110

Ladis, N.N.

- [1] Energy functions for some dynamical systems, *Diff. Eq.*, 8(1972), 599-602
- [2] The topological equivalence of some differential systems, *Diff. Eq.*, 8(1972), 856-859
- [3] The topological equivalence of linear flows, *Diff. Eq.*, 9(1973), 938-947

Lerman, L.M.-Silnikov, L.P.

- [1] On the classification of structurally stable nonautonomous systems of second order with a finite number of cells, *Soviet Math. Dokl.*, 14(1973), 444-448

Lefschetz, S.

- [1] Geometric differential equations, *Intern. sympo. on nonlinear mechanics*, Academic Press, 1967, 1-14

Levine, H.I.

- [1] Singularities of differentiable mappings, *Lecture notes in math.*, 192(1971), 1-89, Springer

Lewowicz, J.

- [1] Stability property of a class of attractors, Trans. A.M.S., 185(1973), 183-198

Lima, E.

- [1] Common singularities of commuting vector fields on 2-manifolds, Commentarii Math. Helv., 39(1964), 97-110
- [2] Commuting vector fields on  $S^3$ , Ann. of Math., 81(1965), 70-81

Livshits, A.N. (Livšič)

- [1] Homology properties of Y-systems, Translation Math. Notes, 10(1971), 758-763
- [2] Cohomology of dynamical systems, Math. of USSR, Izv., 6(1972), 1278-1301

Livshits, A.N.-Sinai, Ja. G. (Livšič-Sinai)

- [1] Invariant measures that are compatible with smoothness for transitive C-systems, Soviet Math. Dokl., 13(1972), 1656-1659

Mañé, R.

- [1] A note on first integrals of vector fields and endomorphisms, Bol. Soc. Brasil Mat., 3(1972), 127-132
- [2] Expansive diffeomorphisms, Warwick 1974, 162-174
- [3] On infinitesimal and absolute stability of diffeomorphisms, Warwick 1974, 151-161
- [4] Persistent manifolds are normally hyperbolic, Bull. A.M.S., 86(1974), 90-91
- [5] Quasi-Anosov diffeomorphisms and hyperbolic manifolds, Mimeographed note

Mañé, R.-Pugh, C.

- Stability of endomorphisms, Warwick 1974, 175-184

Manes, E.G.

- [1] On the point transitivity of symbolic flows, Math. Systems Theory, 10(1977), 259-261

Manning, A.

- [1] Axiom A diffeomorphisms have rational zeta functions, Bull. London Math. Soc., 3(1971), 215-220
- [2] Anosov diffeomorphisms on nilmanifolds, Proc. A.M.S., 38(1973), 423-426

- [3] There are no new Anosov diffeomorphisms on tori, Amer. J. Math., 96 (1974), 422-429
  - [4] Topological entropy and the first homology group, Warwick 1974, 185-190
- Marcus, B.
- [1] Ergodic properties of horocycle flows for surfaces of negative curvature, Ann. of Math., 105(1977), 81-106
- Markley, N.
- [1] Homeomorphisms of the circle without periodic points, Proc. London Math. Soc., (3) 20(1970), 688-698
- Markus, L.
- [1] Global structure of ordinary differential equations on the plane, Trans. A.M.S., 76(1954), 127-148
  - [2] Structurally stable differential systems, Ann. of Math., 73(1961), 1-19
  - [3] Parallel dynamical systems, Topology, 8(1969), 47-58
  - [4] Lectures in differentiable dynamics, Regional Conference Series in Math. No.3, A.M.S., 1969
  - [5] Dynamical systems, Warwick 1974, 354-365
- Markus, L.-Meyer, K.
- [1] Generic Hamiltonian dynamical systems are neither integrable nor ergodic, Memoirs of A.M.S., No.144(1974)
- Marsden, J.E.-McCracken, M.
- [1] The Hopf bifurcation and its applications, Applied mathematical sciences 19, Springer, 1976
- Mather, J.
- [1] Characterization of Anosov diffeomorphisms, Indag. Math., 30(1968), 479-483
  - [2] Simplicity of certain groups of diffeomorphisms, Bull. A.M.S., 80(1974), 271-274
  - [3] Commutators of diffeomorphisms, I, II, Comment. Math. Helv., 49(1974), 512-528, 50(1975), 33-40
- T. Matsumoto
- [1] On the dynamics of electrical networks, J. Diff. Eq., 21(1976), 179-196
- McGehee, R.
- [1] A stable manifold theorem for degenerate fixed points with applications to celestial mechanics, J. Diff. Eq., 14(1973), 70-88

McGehee, R.-Mayer, K.

- [1] Homoclinic points of area preserving diffeomorphisms, Amer. J. Math., 96(1974), 409-421

Mendes, P.

- [1] On stability of dynamical systems on open manifolds, J. Diff. Eq., 16(1974), 144-167

Meyer, K.

- [1] Periodic points of diffeomorphisms, Bull. A.M.S., 73(1967), 615-617
- [2] Energy functions for Morse-Smale systems, Amer. J. Math., 90(1968), 1031-1040
- [3] On the convergence of the zeta functions for flows and diffeomorphisms, J. Diff. Eq., 5(1969), 338-345

Meyer, K.-Palmore, J.

- [1] A generic phenomenon in conservative Hamiltonian systems, Global Analysis, 185-189

Millionshchikov, V.M. (Millionschikov)

- [1] A dense set in a space of smooth dynamic systems, Diff. Eq., 11(1975), 1691-1692

Misiuiewicz, M.

- [1] Diffeomorphisms without any measure with maximal entropy, Bull. Acad. Polon. Sci. Sér. Sci. Math. Astronom. Phys., 21(1973), 903-910

Morimoto, A.

- [1] Stochastically stable diffeomorphisms and Takens' conjecture, Mimeographed note
- [2] Stochastic stability of group automorphisms, Mimeographed note

Moser, J.

- [1] On invariant curves of area preserving mappings of an annulus, Nachr. Akad. Wiss. Göttingen Math.-Phys. Kl, II(1962), 1-20
- [2] On a theorem of D. Anosov, J. Diff. Eq., 5(1969), 411-440
- [3] On a class of quasi-periodic solutions for Hamiltonian systems, Salvador 1971, 281-288
- [4] Stable and random motions in dynamical systems, Ann. of Math. Studies No.77(1973), Princeton Univ. Press

Nemytskii, V.V.

- [1] Some modern problems in the qualitative theory of ordinary differential equations, Russian Math. Surveys, 20 No.4(1965), 1-35

Nemytskii, V.V.-Stepanov, V.V.

- [1] Qualitative theory of differential equations, Princeton Univ. Press, 1960

Neto, A.L.

- [1] Generalized gradient fields and electrical circuits, Bull. A.M.S., 80(1974), 991-995

Newhouse, S.

- [1] On codimension one Anosov diffeomorphisms, Amer. J. Math., 92(1970), 761-770
- [2] Non-density of Axiom A(a) on  $S^2$ , Global Analysis, 191-202
- [3] Hyperbolic limit sets, Trans. A.M.S., 167(1972), 125-150
- [4] On simple arcs between structurally stable flows, Warwick 1974, 209-233
- [5] Diffeomorphisms with infinitely many sinks, Topology, 12(1974), 9-18
- [6] Quasi-elliptic periodic points in conservative dynamical systems, Mimeographed note

Newhouse, S.-Palis, J.

- [1] Hyperbolic nonwandering sets on two-dimensional manifolds, Salvador 1971, 293-302
- [2] Bifurcations of Morse-Smale dynamical systems, Salvador 1971, 303-336
- [3] Cycles and bifurcation theory, Mimeographed note

Newhouse, S.-Palis, J.-Takens, F.

- [1] Stable arcs of diffeomorphisms, Bull. A.M.S., 82(1976), 491-502

Newhouse, S.-Peixoto, M.

- [1] There is a simple arc joining any two Morse-Smale flows, Mimeographed note

Neumann, D.

- [1] Classification of continuous flows on 2-manifolds, Proc. A.M.S., 48 (1975), 73-81
- [2] Dynamical systems with cross-section, Proc. A.M.S., 56(1976), 339-344
- [3] Smoothing continuous flows, J. Diff. Eq., 24(1977), 127-135
- [4] Completely unstable flows on 2-manifolds, Trans. A.M.S., 225(1977), 211-226

Neumann, D.A.-O'Brien, T.

- [1] Global structure of continuous flows on 2-manifolds, J. Diff. Eq., 22(1976), 89-110



Nguyen, N. Z.

- [1] The Kupka-Smale theorem for smooth mappings with invariant measure, Soviet Math. Dokl., 13(1972), 934-937

Nikishin, N.A. (Nikišin)

- [1] Fixed points of diffeomorphisms of two-dimensional spheres preserving an oriented plane, Functional Analysis Appl., 8(1974), 77-79

Nitecki, Z.

- [1] Non-singular endomorphisms of the circle, Global Analysis, 203-220
- [2] Factorization of nonsingular circle endomorphisms, Salvador 1971, 367-373
- [3] On semi-stability for diffeomorphisms, Invent. Math., 14(1971), 83-122
- [4] Differentiable dynamics, The M.I.T. Press, 1971

Nitecki, Z.-Shub, M.

- [1] Filtrations, decompositions, and explosions, Amer. J. Math., 97(1975), 1029-1049

Niwa, T.

- [1] Homomorphisms of differentiable dynamical systems, J. Math. Kyoto Univ., 14(1974), 597-605

Norton, V.-O'Brien, T.

- [1] Anosov flows and expansiveness, Proc. A.M.S., 40(1973), 625-628

Oka, M.

- [1] Expansive flows and their centralizers, Nagoya Math. J., 64(1976), 1-15

Otsuki, N.

- [1] Geodesic flows and isotopic flows, Proc. Jap. Acad., 45(1969), 10-13
- [2] A characterization of Anosov flows for geodesic flows, Hiroshima Math. J., 4(1974), 374-412

Oxtoby, J.C.-Ulam, S.M.

- [1] On the existence of a measure invariant under a transformations, Ann. of Math., 40(1939), 560-566
- [2] Measure-preserving homeomorphisms and metrical transitivity, Ann. of Math., 42(1941), 874-920

Palis, J.

- [1] On the local structure of hyperbolic points in Banach spaces, Anais da Acad. Brasileira de Ci., 40(1968), 263-266
- [2] On Morse-Smale dynamical systems, Topology, 8(1969), 385-404

- [3] A note on  $\Omega$ -stability, Global Analysis, 221-222
  - [4]  $\Omega$ -explosions, Proc. A.M.S., 27(1971), 85-90
  - [5] Arcs of dynamical systems: bifurcation and stability, Warwick 1974, 48-52
  - [6] Vector fields generate few diffeomorphisms, Bull. A.M.S., 80(1974), 503
- Palis, J.-Pugh, C.
- [1] Fifty problems in dynamical systems, Warwick 1974, 345-353
- Palis, J.-Pugh, C.-Shub, M.-Sullivan, D.
- [1] Genericity theorems in topological dynamics, Warwick 1974, 241-250
- Palis, J.-Smale, S.
- [1] Structural stability theorems, Global Analysis, 223-232
- Palis, J.-Takens, F.
- [1] Topological equivalence of normally hyperbolic dynamical systems, Mimeographed note
- Parry, W.
- [1] Ergodic properties of affine transformations and flows on nilmanifolds, Amer. J. Math., 91(1969), 757-771
- Parry, W.-Sullivan, D.
- [1] A topological invariant of flows on 1-dimensional spaces, Topology, 14(1975), 297-300
- Peixoto, M.
- [1] On structural stability, Ann. of Math., 69(1959), 199-222
  - [2] Structural stability on two-dimensional manifolds, Topology, 1(1962), 101-120
  - [3] Qualitative theory of differential equations and structural stability, Intern. sympo. on nonlinear diff. eq. and nonlinear mechanics, Academic Press, 1967
  - [4] On an approximation theorem of Kupka and Smale, J. Diff. Eq., 3(1967), 214-227
  - [5] On the classification of flows on 2-manifolds, Salvador 1974, 389-419
- Peixoto, M.-Pugh, C.
- [1] Structurally stable systems on open manifolds are never dense, Ann. of Math., 87(1968), 423-430
- Percell, P.B.
- [1] Structural stability on manifolds with boundary, Topology, 12(1973), 123-144

Perrizo, W.

- [1] Extensions of minimal flows on manifolds, Proc. A.M.S., 59(1976), 383-388

Piljugin, S. Ju.

- [1] Phase diagrams of systems of differential equations satisfying Axiom A, Diff. Eq., 9(1973), 491-493
- [2] The realizability of phase diagrams of coarse three-dimensional dissipative systems, Diff. Eq., 10(1974), 420-421
- [3] Morse-Smale systems with identical phase diagrams, Diff. Eq., 10(1974), 628-632

Pixton, D.

- [1] Wild unstable manifolds, Topology, 16(1977), 167-172

Plante, J.F.

- [1] Diffeomorphisms with invariant line bundles, Invent. Math., 13(1971), 325-334
- [2] Anosov flows, Amer. J. Math., 94(1972), 729-754
- [3] Homology of closed orbits of Anosov flows, Proc. A.M.S., 37(1973), 297-300
- [4] The homology class of an expanded invariant manifold, Warwick 1974, 251-256

Plante, J.F.-Thurston, W.P.

- [1] Anosov flows and the fundamental group, Topology, 11(1972), 147-150

Pliss, V.A.

- [1] An analysis of the necessity of the conditions of Smale and Robbin for the coarseness of periodic systems of differential equations, Diff. Eq., 8(1972), 735-744

Plykin, R.V.

- [1] The topology of basic sets of Smale diffeomorphisms, Math. of USSR Sbornik, 13(1971), 297-307
- [2] Sources and sinks of A-diffeomorphisms of surfaces, Math. of USSR Sbornik, 23(1974), 233-253

Porteous, H.L.

- [1] Anosov diffeomorphisms of flat manifolds, Topology, 11(1972), 307-316

Pugh, C.C.

- [1] Structural stability on M, An. Acad. Brasil Ci., 39(1967), 45-48

- [2] The closing lemma, Amer. J. Math., 89(1967), 956-1009
  - [3] An improved closing lemma and a general density theorem, Amer. J. Math., 89(1967), 1010-1022
  - [4] On a theorem of P. Hartman, Amer. J. Math., 91(1969), 363-367
  - [5] Hilbert's 16th problem, Warwick 1974, 55-56
  - [6] On the entropy conjecture, Warwick 1974, 257-261
  - [7] Against the  $C^2$ -closing lemma, J. Diff. Eq., 17(1975), 435-443
- Pugh, C.-Robinson, C.
- [1] The  $C^1$  closing lemma, including Hamiltonians, Mimeographed note
- Pugh, C.-Shub, M.
- [1] Linearization of normally hyperbolic diffeomorphisms and flows, Invent. Math., 10(1970), 187-198
  - [2] The  $\Omega$ -stability theorem for flows, Invent. Math., 11(1971), 150-158
  - [3] Ergodicity of Anosov actions, Invent. Math., 15(1972), 1-23
  - [4] Axiom A actions, Invent. Math., 29(1975), 7-38
- Pugh, C.-Walker, R.-Wilson, W. Jr.
- [1] On Morse-Smale approximations, A counterexample, J. Diff. Eq., 23(1977), 173-182
- Reeken, M.
- [1] Stability of critical points under small perturbations, I, II, Manuscripta Math., 7(1972), 387-411, 8(1973), 69-92
- Rice, P.M.
- [1] Circular flows on  $S^3$ , Math. Scand., 21(1967), 128-135
- Robbin, J.
- [1] Stable manifolds of semi-hyperbolic fixed points, Ill. J. Math., 15(1970), 595-609
  - [2] A structural stability theorem, Ann. of Math., 94(1971), 447-493
  - [3] Topological conjugacy and structural stability for discrete dynamical systems, Bull. A.M.S., 78(1972), 923-952
- Robinson, R.C.
- [1] Generic properties of conservative systems, I, II, Amer. J. Math., 92(1970), 562-603, 897-906
  - [2] A global approximation theorem for Hamiltonian systems, Global Analysis, 233-243
  - [3] Differentiable conjugacy near compact invariant manifolds, Bol. Soc. Brasil. Mat., 2(1971), 33-44

- [4]  $C^r$  structural stability implies Kupka-Smale, Salvador 1971, 443-449
  - [5] Closing stable and unstable manifolds on the two sphere, Proc. A.M.S., 41(1973), 299-303
  - [6] Structural stability of vector field, Ann. of Math., 99(1974), 154-175
  - [7] Structural stability of  $C^1$  flows, Warwick 1974, 262-277
  - [8] Structural stability of  $C^1$  diffeomorphisms, J. Diff. Eq., 22(1976), 28-73
  - [9] A quasi-Anosov flow that is not Anosov, Mimeographed note
- Robinson, C.-Williams, R.F.
- [1] Finite stability is not generic, Salvador 1971, 451-462
  - [2] Classification of expanding attractors; An example, Topology, 15(1976), 321-324
- Rod, D.L.
- [1] Hyperbolic periodic orbits, J. Diff. Eq., 24(1977), 329-348
- Rohrer, R.A.
- [1] Circuit theory, McGraw-Hill, 1970
- Rokhlin, V.A.
- [1] New progress in the theory of transformations with invariant measure, Russian Math. Surveys, 15 No.4(1960), 1-22
  - [2] Lectures on the entropy theory of measure-preserving transformations, Russian Math. Surveys, 22 No.5(1967), 1-52
- Rosenberg, H.
- [1] A generalization of Morse-Smale inequalities, Bull. A.M.S., 70(1964), 422-427
  - [2] Actions of  $\mathbb{R}^n$  on manifolds, Commentarii Math. Helv., 41(1966-67), 170-178
- Ruelle, D.
- [1] Bifurcation in the presence of a symmetry groups, Arch. Rat. Mech. Anal., 51(1973), 136-152
  - [2] A measure associated with Axiom A attractors, Amer. J. Math., 98(1976), 619-654
  - [3] Zeta functions for expanding maps and Anosov flows, Invent. Math., 34 (1976), 231-242
  - [4] Generalized zeta-functions for Axiom A basic sets, Bull. A.M.S., 82 (1976), 153-156

Ruelle, D.-Sullivan, D.

- [1] Currents, flows and diffeomorphisms, *Topology*, 14(1975), 219-327

Ruelle, D.-Takens, F.

- [1] On the nature of turbulence, *Commun. Math. Phys.*, 20(1971), 167-192

Sacker, R.

- [1] A new approach to the perturbation theory of invariant surfaces, *Comm. Pure Appl. Math.*, 18(1965), 717-732
- [2] A perturbation theorem for invariant manifolds and Hölder continuity, *J. Math. Mech.*, 18(1969), 705-762

Sacker, R.-Sell, G.

- [1] On the existence of periodic solutions on 2-manifolds, *J. Diff. Eq.*, 11(1972), 449-463
- [2] A note on Anosov diffeomorphisms, *Bull. A.M.S.*, 80(1974), 278-280
- [3] Existence of dichotomies and invariant splittings for linear differential systems, I, II, *J. Diff. Eq.*, 15(1974), 429-458, *i.b.i.d.*, 22(1976), 478-496

[4] A spectral theory for linear differential systems, Mimeographed note  
T. Sasaki

- [1] Some examples of stochastically stable homeomorphisms, Mimeographed note

Schwartzman, Sol.

- [1] Parallel vector fields and periodic orbits, *Proc. A.M.S.*, 44(1974), 167-168

Schweitzer, P.A.

- [1] Counterexamples to the Seifert conjecture and opening closed leaves of foliations, *Ann. of Math.*, 100(1974), 386-400

Sears, M.

- [1] Weakly ergodic homeomorphisms, *Proc. A.M.S.*, 58(1976), 319-324

Seifert, H.

- [1] Closed integral curves in 3-space and isotopic two-dimensional deformations, *Proc. A.M.S.*, 1(1950), 287-302

Selgracte, J.

- [1] Isolated invariant sets for flows on vector bundles, *Trans. A.M.S.*, 203(1975), 359-390

Sell, G.R.

- [1] The structure of a flow in the vicinity of an almost periodic motion,

Mimeographed note

Shahshahani, S.

- [1] Dissipative systems on manifolds, *Invent. Math.*, 16(1972), 177-190

Shiraiwa, K. (白岩 謙一)

- [1] 力学系の理論, 岩波書店 1974

- [2] Anosov 微分写像について, *数学*, 26 (1974), 97-108

- [3] Some conditions on Anosov diffeomorphisms, *Manifolds-Tokyo 1973*, 205-209, Univ. of Tokyo Press (1976)

Shoshitaishvili, A.N.

- [1] Bifurcations of topological type at singular points of parametrized vector fields, *Functional Analysis Appl.*, 6(1972), 169-170

Shub, M.

- [1] Periodic orbits of hyperbolic diffeomorphisms and flows, *Bull. A.M.S.*, 75(1969), 57-58

- [2] Endomorphisms of compact differentiable manifolds, *Amer. J. Math.*, 91(1969), 175-199

- [3] Expanding maps, *Global Analysis*, 273-276

- [4] Stability and genericity for diffeomorphisms, *Salvador 1971*, 493-514

- [5] Structurally stable diffeomorphisms are dense, *Bull. A.M.S.*, 78(1972), 817-818

- [6] Dynamical systems, filtrations and entropy, *Bull. A.M.S.*, 80(1974), 27-41

Shub, M.-Sullivan, D.

- [1] A remark on the Lefschetz fixed point formula for differentiable maps, *Topology*, 13(1974), 189-191

- [2] Homology theory and dynamical systems, *Topology*, 14(1975), 109-132

Shub, M.-Williams, R.F.

- [1] Future stability is not generic, *Proc. A.M.S.*, 22(1969), 483-484

- [2] Entropy and stability, *Topology*, 14(1975), 329-338

Siegel, C.L.

- [1] Note on differential equations on the torus, *Ann. of Math.*, 46(1945), 423-428

Sigmund, K.

- [1] Generic properties of invariant measures for Axiom A diffeomorphisms, *Invent. Math.*, 11(1970), 99-109

- [2] On mixing measures for Axiom A diffeomorphisms, Proc. A.M.S., 36 (1972), 497-504
- [3] On the space of invariant measures for hyperbolic flows, Amer. J. Math., 94(1972), 31-37
- [4] On the time evolution of statistical states for Anosov systems, Math. Z., 138(1974), 183-189

✓ Sil'nikov, L.P.

- [1] The existence of a countable set of periodic motions in the neighborhood of a homoclinic curve, Soviet Math. Dokl., 8(1967), 102-106
- [2] Structure of the neighborhood of a homoclinic tube of an invariant torus, Soviet Math. Dokl., 9(1968), 624-628

Simon, C.

- [1] On a classification of a Baire set of diffeomorphisms, Bull. A.M.S., 77(1971), 783-787
- [2] A 3-dimensional Abraham-Smale example, Proc. A.M.S., 34(1972), 629-630
- [3] Instability in  $\text{Diff}^r(T^3)$  and the non-genericity of rational zeta functions, Trans. A.M.S., 174(1972), 217-242
- [4] A bound for the fixed point index of an area-preserving map with applications to mechanics, Invent. Math., 26(1974), 187-200

Simon, C.-Titus, C.

- [1] Removing index zero singularities with  $C^2$ -small perturbations, Warwick 1974, 278-286

Sinai, Ja. G.

- [1] Markov partitions and C-diffeomorphisms, Functional Analysis Appl., 2(1968), 61-82

Sine, R.

- [1] A note on the ergodic properties of homeomorphisms, Proc. A.M.S., 57 (1976), 169-172

Smale, S.

- [1] Morse inequalities for a dynamical system, Bull. A.M.S., 66(1960), 43-49
- [2] On gradient dynamical systems, Ann. of Math., 74(1961), 199-206
- [3] Stable manifolds for differential equations and diffeomorphisms, Ann. Scuola Norm. Sup. Pisa, 3(3)/7(1963), 97-116
- [4] Diffeomorphisms with many periodic points, Differential and combinatorial topology, Princeton Univ. Press, 1964



- [5] Structurally stable systems are not dense, Amer. J. Math., 88(1966), 491-496
  - [6] Differentiable dynamical systems, Bull. A.M.S., 73(1967), 747-817
  - [7] The  $\Omega$ -stability theorem, Global Analysis, 289-298
  - [8] Topology and mechanics, I, II, Invent. Math., 10(1970), 305-311, 11 (1970), 45-64
  - [9] Notes on differentiable dynamical systems, Global Analysis, 227-287
  - [10] Stability and isotopy in discrete dynamical systems, Salvador 1971, 527-530
  - [11] On the mathematical foundation of electrical circuit theory, J. Diff. Geometry, 7(1972), 193-210
  - [12] Global analysis and economics, Salvador 1971, 531-544
  - [13] Optimizing several functions, Manifolds-Tokyo 1973, 69-76
  - [14] Sufficient conditions for an optimum, Warwick 1974, 287-292
- Smith, J.W.
- [1] Commuting vector fields on open manifolds, Bull. A.M.S., 75(1969), 1013-1016
- Sondow, J.D.
- [1] Fixed points of Anosov maps of certain manifolds, Proc. A.M.S., 61 (1976), 381-384
- Sotomayor, J.
- [1] Generic one-parameter families of vector fields on two-dimensional manifolds, Publ. Math. I.H.E.S., No.43(1974), 5-46
  - [2] Structural stability and bifurcation theory, Salvador 1971, 541-560
  - [3] Generic bifurcations of dynamical systems, Salvador 1971, 561-582
- Strelcyn, J.M.
- [1] Flots sur le tore et nombres de rotation, Bull. Soc. Math. France, 100(1972), 195-208
- Sullivan, D.
- [1] A new flow, Bull. A.M.S., 82(1976), 331-332
- Sullivan, D.-Williams, R.F.
- [1] On the homology of attractors, Topology, 15(1976), 259-262
- Takaki, K.
- [1] Lipeomorphisms close to an Anosov diffeomorphism, Nagoya J. Math., 53(1974), 71-82

Takens, F.

- [1] Hamiltonian systems, Generic properties of closed orbits and local perturbation, Math. Ann., 188(1970), 304-312
- [2] A  $C^1$  counterexample to Moser's twist theorem, Indag. Math., 33(1971), 378-386
- [3] Partially hyperbolic fixed points, Topology, 10(1971), 133-147
- [4] On Zeeman's tolerance stability conjecture, Manifolds-Amsterdam 1970, Lecture notes in math., No.197(1971), Springer, 209-219
- [5] Integral curves near mildly degenerate singular points of vector fields, Salvador 1971, 599-617
- [6] Homoclinic points in conservative systems, Invent. Math., 18(1972), 267-292
- [7] Unfoldings of certain singularities of vector fields: Generalized Hopf bifurcations, J. Diff. Eq., 14(1973), 476-493
- [8] Normal forms for certain singularities of vector fields, Ann. Inst. Fourier, 23(2)(1973), 163-195
- [9] Singularities of vector fields, Publ. Math. I.H.E.S., 43(1974), 47-100
- [10] Tolerance stability, Warwick 1974, 293-304
- [11] Geometric aspects of nonlinear RLC networks, Warwick 1974, 305-331

Takens, F.-White, W.

- [1] Vector field with nonwandering points, Amer. J. Math., 98(1976), 415-425

Thom, R.

- [1] Stabilité structurelle et morphogénès, Benjamin, 1972
- [2] Introduction à la dynamique qualitative, Astérisque Société Math. France, 31(1976), 3-13

Thomas, R.S.D.

- [1] Commuting continuous flows on manifolds, Math. Systems Theory, 4(1970), 193-197

Thomas, E.S. Jr.

- [1] One-dimensional minimal sets, Topology, 12(1973), 233-242

Thompson-Hunt

- [1] Towards unified bifurcation theory, Z. Angew. Math. Phys., 26(1975),

Togawa, Y.

- [1] Generic Morse-Smale diffeomorphisms have only trivial symmetries, Mimeographed note

[2] Centralizers of  $C^1$ -diffeomorphisms, Mimeographed note

Tomter, P.

[1] Anosov flows on infrahomogeneous spaces, Global Analysis, 299-328

[2] On the classification of Anosov flows, Topology, 14(1975), 179-190

Ueda, Y.

[1] Some problems in the theory of nonlinear oscillations, Nippon Printing and Publishing Company, Ltd., 1968

上田一赤松一林

[1] 非線形常微分方程式の計算機シミュレーションと非周期振動, 電気通信学会論文誌, 56 (1973), 218-225

Umanskii

[1] The scheme of a three-dimensional Morse-Smale dynamical system without closed trajectories, Soviet Math. Dokl., 17(1976), 1479-1482

Van Kampen, E.R.

[1] The topological transformations of a simple closed curve into itself, Amer. J. Math., 57(1935), 142-152

Verjovsky, A.

[1] Flows with cross sections, Proc. Nat. Acad. Sci. U.S.A., 66(1970), 1154-1156

Walters, P.

[1] Anosov diffeomorphisms are topologically stable, Topology, 9(1970), 71-78

Wan, Y.H.

[1] On the uniqueness of invariant manifolds, J. Diff. Eq., 24(1977), 268-273

Weinstein, A.

[1] Perturbation of periodic manifolds of Hamiltonian systems, Bull. A.M.S., 77(1971), 814-818

[2] Symplectic manifolds and their Lagrangian submanifolds, Advances in Math., 6(1971), 329-346

[3] Lagrangian submanifolds and Hamiltonian systems, Ann. of Math., 98(1973), 377-410

White, W.

[1] On the tolerance stability conjecture, Salvador 1971, 663-665

[2] An Anosov translation, Salvador 1971, 667-670

Williams, R.F.

- [1] One dimensional non-wandering sets, *Topology*, 6(1967), 473-478
- [2] The zeta functions of an attractor, *Conf. on the topology of manifolds*, Prindle, Weber & Schmidt, 1968, 155-161
- [3] The zeta functions in global analysis, *Global Analysis*, 335-340
- [4] The 'DA' maps of Smale and structural stability, *Global Analysis*, 329-334
- [5] Classification of one dimensional attractors, *Global Analysis*, 341-362
- [6] Classification of subshift of finite type, *Ann. of Math.*, 98(1973), 120-153, 99(1974), 380-381
- [7] Expanding attractors, *Publ. Math. I.H.E.S.*, No.43(1974), 169-203
- [8] Cohomology of expanding attractors, *Warwick 1974*, 41
- [9] Further results on expansive mappings, *Proc. A.M.S.*, 58(1976), 284-288

Wilson, F.W.

- [1] On the minimal sets of non-singular vector fields, *Ann. of Math.*, 84 (1966), 529-536
- [2] Some examples of vector fields on the 3-sphere, *Ann. Inst. Fourier*, 20(1970), (2), 1-20

Zeeman, C.

- [1] Morse inequalities for diffeomorphisms with shoes and flows with solenoids, *Warwick 1974*, 44-47

Zehnder, E.

- [1] Homoclinic points near elliptic fixed points, *Comm. Pure Appl. Math.*, 26(1973), 131-182