

Final Report EPSRC Grant GR/R73171/01 Geometric & Probabilistic Aspects of Dynamical Systems

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November 23, 2005

Description and aim of the grant

This grant was in support of the 2002-2003 Warwick Symposium on *Geometric & Probabilistic Aspects of Dynamical Systems*. The principal organisers were Sebastian van Strien, Peter Walters and co-investigators Oleg Kozlovski, Omri Sarig and Adam Epstein.

As stated in the application, the principal aims of this symposium were:

- to run a symposium of international excellence in Dynamical Systems and related areas
- to bring top mathematicians together to interact, collaborate and discuss the latest developments of the subject
- to make progress on major problems in this area
- to encourage maximal British participation in the programmes

The outcomes of this grant.

During the academic year 2002-2003, the Warwick Symposium consisted of two workshops and two major international conferences. The workshops were more focused and specialized, whereas the two conferences brought together a wider range of specialists. Three additional workshops were held in 2004 and 2005. Several participants were 'long stay' visitors to Warwick, and many top mathematicians in

the field of dynamical systems participated in one or more of the meetings, see the list of the speakers listed below. A conference proceeding was produced for one of the July 2003 meeting.

Distinctive features of the symposium included

- A strong emphasis on breadth during the two conferences, with an emphasis of talks given by the most active people in the field. The feedback we received was very positive about this aspect.
- A number of smallish workshops where people actually were able to exchange ideas, and start collaborations.
- An attempt to create a 'school' within a conference, by always having mini-courses at each meeting. This enabled many young people to get much more out of the meetings than would have been possible otherwise. Also it enabled experienced researchers to get a better feel for an area which is not too close to their own.

The total number of participants supported from this grant was over 550. Although the major financial support for the Symposium came from this EPSRC grant, some of the participants were also supported by an ESF grant (PRODYN).

Description of the two larger conferences

Conference on Symbolic Dynamics and Ergodic Theory, 7-18 July 2003

Of the 136 participants, there were 46 UK participants. Mini courses (each consisting of 3 one hour talks) were organised on

- Classification of Subshifts of Finite Types (Boyle)
- Interval exchange transformations (Ferenczi)
- Independent processes are completely extremal (Kalikow)

There were about 50 one hour talks, given by Krieger (Heidelberg), Coelho (York), Berger (TU Vienna), Boyle (Maryland), Buzzi (Ecole Polytechnique), Simon (TU Budapest), Das (Louisville), M. Sullivan (S. Illinois), Aaronson (Tel-Aviv), Plykin (Obninsk), Gordin (Steklov Inst), Smorodinsky (Tel-Aviv), Kaimanovich (Rennes), Volny (Rouen), Greschönig (Viena), Kesseböhmer (Bremen), S. Katok (Penn-State), E.B. Dynkin (Cornell), Lemanczyk (Torun), Dong Pyo Chi (Seoul), Nakaishi (Tokyo), Sataev (Obninsk), A. Katok (Penn-State), Ferenczi (Luminy), Stimac (Zagreb),

Bruin (Surrey), Polulyakh (Kiev), Petersen (N. Carolina), Kolyada (Kiev), Sidorov (Manchester), Baladi (Jussieu), Ward (East Anglia), Gouezel (Orsay), Gouëzel Melbourne (Surrey), Kalikow (Memphis), Marklov (Bristol), Markloff Thouvenot (Paris 6), Begun (Toronto), Lenci (Stevens Institute), Denker (Göttingen), Haydn (S. California), Ledrappier (Notre-Dame), Sharp (Manchester), H. Weiss (Penn State), Pollicott (Manchester).

The proceedings of this workshop have been edited by M. Denker and O. Sarig and were published as a special volume of the Stochastics & Dynamics journal (volume 4, 2004).⁷

Conference on Geometric Aspects of Dynamical Systems, 21-25 July 2003

The aim of this conference was to look at geometric aspects of dynamical systems, with a particular emphasis and mini courses on

- statistical properties of hyperbolic systems (Liverani)
- renormalization theory (Smania)
- non-uniformly hyperbolicity (various)
- the closing lemma (Gutierrez)
- density of hyperbolicity (Shen)

About 90 participants were registered for this meeting (33 of which were from the UK), and 42 talks (some in parallel sessions) with speakers Avila (College de France), Baranski (Warsaw university), Bialy (Tel Aviv University), Buzzi (École Polytechnique), Choe (Korea Advanced Institute of Science and Technology), Collins (Centrum voor Wiskunde en Informatica), Comerford (Univ. Cal. Riverside), Dufraine (July University of Warwick), Gutierrez (ICMC-Universidade de Sao Paulo), Hasselblatt (Tufts), Honary (Ispahan), Hric (Matej Bel University), Hu (Pennsylvania State University), Jaeger (University of Erlangen-Nürnberg), Kahng (Williamsburg), Koltsova (Nizhny Novgorod State University), Kolyada (Kiev), Liverani (University of Rome "Tor Vergata"), Misiurewicz (IUPUI), Navas (Univ. Lyon), Oliveira (IMPA), Olivier (Universite de Provence), Paternain (University of Cambridge), Pinto (Porto), Rempe (Kiel/Warwick), Schmeling (Lund, Sweden), Sharkovsky (NAS of Ukraine), Shen (University of Warwick), Smania (Sao Paolo), Tahzibi (IMPA), Urbanski (University of North Texas), Vaienti (Centre de Physique Theorique), Vargas (Univ. de Sao Paulo), Vasquez (IMPA), Vlasenko (Kiev), Zajt (Pedagogical University).

The five workshops

Workshop on Real and Complex One-Dimensional Dynamics, 9-13 December, 2002

Most talks of this workshop dealt with situations which were 'almost' one-dimensional, or where one uses methods from holomorphic dynamics to study real one-dimensional systems. In particular there were talks on parameter exclusion (a la Jakobson, Benedicks-Carleson), conformal repellers, piecewise isometric maps, renormalization theory and skew-products over expanding maps. Of the 59 participants, there were 36 UK participants.

The programme included talks by: Jerome Buzzi (CMAT, École Polytechnique) Andrzej Bis' (University of Lodz) Alberto A. Pinto (Universidade do Porto) Flavio Ferreira (Instituto Politecnico do Porto) Alexei Tsygvinstev (Loughborough University) Krzysztof Baranski (Warsaw University) Hans Henrik Rugh (Université de Cergy-Pontoise) Feliks Przytycki (Polish Academy of Sciences) Henk Bruin (University of Groningen) Stefano Luzzatto (Imperial College) Artur Avila (Collège de France) Jacek Graczyk (Orsay) Oleg Stenkin (Imperial College) Samuel Senti (Pennsylvania State University) Genadi Levin (Hebrew University of Jerusalem) Oksana Volkova (Nat. Acad. Sci. of Ukraine) Peter Ashwin (University of Exeter) Christopher Penrose (Queen Mary, London) Mohiniso Hidirova (Moscow State University) Andrei Sivak (Nat. Acad. Sci. of Ukraine) Evgueni Sataev (Obninsk Inst. of Nucl. Power) Georgi Chakvetadze (Hebrew University, Jerusalem) Konstantin Khanin (University of Cambridge)

Workshop on Holomorphic Dynamics, 4-12 April 2003

This conference covered aspects of holomorphic dynamics, ranging from fractal dimensions, Teichmüller theory, linearizability, higher dimensional dynamics, surgery. Mini courses were held on

- Siegel disks of quadratic polynomials (Buff, Toulouse),
- On the geometry and dynamics of holomorphic flows (Gomez-Mont, Mexico)
- On the combinatorics of rational maps as holomorphic dynamical systems (Pilgrim, Indiana)
- Views of the space of quadratic rational maps (Rees, Liverpool)
- Degenerate parabolic points and parameter space discontinuities (Epstein, Warwick).

Of the 86 participants about 40 were from the UK. The quality of the talks, and the range of topics covered was impressive. The speakers included:

DeMarco (Chicago), Singh (Jammu, India), Rippon (Open University), Stallard (Open University), Schleicher (Bremen), Dominguez (Barcelona), Geyer (Michigan), Rempe (Warwick), Fagella (Barcelona), Zdunik (Warsaw), Urbanski (Denton), Kotus (Warsaw), Earle (Cornell), Markovic (Warwick), Brakalova (Stony Brook), Penrose (Queen Mary), Bullett (Queen Mary), Buff (Toulouse), Okuyama (Shizuoka, Japan), Makienko, Oudkerk, Gomez-Mont (Mexico), Rebelo (Stony Brook), Shcherbakov (Moscow), Deroin (Lyon), Hruska (Stony Brook), Haissinsky (Marseille), Kameyama (Osaka, Japan), Rees (Liverpool), Pilgrim (Indiana), Tan Lei (Paris), Epstein (Warwick), Avila (Paris), Levin (Hebrew Univ), Shen (Warwick), Perez (Stony Brook).

Combinatorial Methods in Complex Dynamics, 23-24 April 2004

This two-day workshop was held around visits of Kiwi and Avila to Warwick. In total it attracted 22 participants (6 overseas, 7 UK + 9 Warwick). Among the speakers were: Jan Kiwi (Chili), Adam Epstein (Warwick), Rippon (Open Univ), Sebastian van Strien (Warwick), Artur Avila (Paris), Richard Oudkerk, Lasse Rempe (Warwick).

Workshop of Holomorphic Dynamics, 6-11 December 2004

Among the talks at the conference there will were three minicourses of two or three lectures each, given by

- On the Marmi-Moussa-Yoccoz conjecture (Chéritat, Toulouse)
- Density of Hyperbolicity (Kozlovski, Warwick)
- Renormalization for indifferent fixed points (Shishikura, Kyoto)

There were 66 participants, including 31 from the UK. Bergweiler (Kiel), Rees (Liverpool), Shishikura (Kyoto), Levin (Hebrew University), Kozlovski (Warwick), Keen (New York), Kawahira (Nagoya), Haissinsky (Marseille), Todd (Surrey), Rückert (Bremen), Penrose (Queen-Mary), Cheritat (Toulouse), Rempe (Warwick), Urbanski (Denton), Rippon (Open University), Comerford (Bremen), Dominguez (Mexico), Jung (Bremen), Rottenfusser (Bremen), Prellberg (London), Oversteegen (Birmingham, USA), Shishikura (Kyoto), Henriksen (Lyngby, Denmark), Paluba (Warwick), Karpinska (Warsaw), Freiburger (Queen Mary), Shubert (Kiel), Look (Boston), Bullet (Queen Mary), Smania (Sao Paulo), Morosawa (Kochi, Japan), Inoue (Kyoto), Hemke (Kiel), Nakane (Kanagawa, Japan), Moreno Rocha (Medford, USA), Stallard (Open University), Devaney (Boston).

Workshop on Holomorphic Dynamics, 22-26 August 2005

The general theme of this meeting was transcendental dynamics, and an exploration of two very different ways to go beyond finite type entire maps - infinite type entire maps on the one hand, finite type maps with arbitrary domain on the other. The main part of this meeting consisted of a number of mini-courses consisting each of 3 lectures, and which were aimed at introducing PhD students into active research topics. Apart from the speakers, there were PhD students from the UK, from Warsaw, Bremen and Goettingen. In total there were 22 participants. The topics of the mini-courses were primarily on transcendental dynamics:

- Dynamics of Finite Type Maps, Epstein (Warwick)
- Dynamics of Ahlfors Maps, Oudkerk (Manchester)
- Escaping points of bounded type entire functions, Rempe (Warwick), Rückert (Bremen) and Schleicher (Bremen)
- Escaping points of meromorphic functions, Rippon (Open Univ)
- Density of hyperbolicity in dimension one, van Strien (Warwick)

In addition there were talks by: Pollicott (Warwick) Kesseboehmer (Bremen) Rückert (Bremen) Wendt (Bremen) Badenska (Warsaw) Clifford (Nottingham).

Summary

The meetings were of a very high quality of the meetings. Moreover, many activities were organised, a large number of high-level participants supported, and many mini-courses in topical subjects were given. The symposium was a definite success and helped to strengthen dynamics in the UK.