SEVENTH FRAMEWORK PROGRAMME

MARIE CURIE ACTIONS

People

International Research Staff Exchange Scheme

ANNEX 1 - Description of Work

PART A

1. *Grant Agreement* details

Full title: Brazilian–European Partnership in Dynamical Systems

Acronym: BREUDS

Proposal Number: 318999

Scientific Panel: Mathematics (MAT)

Grant Agreement Number: PIRSES-GA-2012-316788

Duration of the project: 48 months

Project start date: 1 January 2013

2 List of participants (beneficiaries and partner organisations)

No	Partner name	Short name	Count
1	*Imperial College of Science, Technology and Medicine*	*Imperial*	UK
2	*The University of Warwick*	*Warwick*	UK
3	*The University of Liverpool*	*Liverpool*	UK
4	*University of Surrey*	*Surrey*	UK
5	*Queen Mary and Westfield College, University of London*	*QMUL*	UK
6	*The University Court of the University of St Andrews*	*StAndrews*	UK
7	*Stichting VU-VUmc*	*VUA*	NL
8	*Centre National de la Recherche Scientifique*	*CNRS*	FR
9	*Universite de Marne la Vallee*	*MLV*	FR
10	*Universitaet Augsburg*	*Augsburg*	DE
11	*Technische Universitaet Dresden*	*Dresden*	DE
12	*Universita di Pisa*	*Pisa*	IT
13	*United Nations Educational, Scientific and Cultural Organization – UNESCO*	*UNESCO-ICTP*	FR
14	*Universidade do Porto*	*Porto*	PT
15	*Universidade da Beira Interior*	*UBI*	PT
16	*Instituto Superior Tecnico*	*IST*	PT
17	*Universitat Autonoma de Barcelona*	*UAB*	ES
18	*Universitat Politecnica de Catalunya*	*UPC*	ES
19	*Universidad de Sevilla*	*USE*	ES
20	*Instytut Matematyczny Polskiej Akademii Nauk.*	*IMPAN*	PL
21	*Kungliga Tekniska Hoegskolan*	*KTH*	SE
22	Universidade Dederal do Rio de Janeiro	UFRJ	BR
23	IMPA – Instituto Nacional de Matemática Pura e Aplicada	IMPA	BR
24	Universidade de Sao Paulo	USP	BR
25	Universidade Federal Fluminense	UFF	BR
26	Universidade Federal da Bahia	UFBA	BR
27	Universidade Estadual de Campinas	UNICAMP	BR
28	Universidade Federal do Rio Grande do Sul	UFRGS	BR
29	Universidade Federal de Alagoas	UFAL	BR
30	Universidade Estadual Paulista – UNESP	UNESP	BR
31	Pontificia Universidade Catolica do Rio de Janeiro	PUC-RIO	BR
32	Universidade Federal de Minas Gerais	UFMG	BR

3 Project summary

This is a project for a partnership between leading Brazilian and European research groups in dynamical systems, a prominent subject in mathematics. An extensive consortium of European and Brazilian institutions will collaborate to provide world leading critical mass and support for research on the very forefront of the field. Work Packages reflect parallel priorities in the research. Transfer of knowledge is facilitated by two large conferences and five smaller workshops. The project has excellent strategic value in view of the development of closer ties in higher education and research between the European Research Area and Brazil.

Part B

4. Quality of the Exchange Programme

4.1 Objective and relevance of the joint exchange programme

The field of dynamical systems concerns the study of evolution, as modelled – for instance, but not only – through differential equations, in particular with a view to the understanding of the qualitative behaviour of solutions. The unique position of dynamical systems theory is that it genuinely sits and bridges between more classical fields of mathematics, such as analysis, topology, geometry, algebra, number theory, and probability theory. Moreover, the dynamical systems theory has influenced and inspired recent successful developments within these classical fields. As with much of modern mathematics, the foundations for the development of the field was laid by Henri Poincaré, who in his celebrated work on celestial mechanics discovered the potentially sensitive and complicated behaviour of dynamical systems described by relatively simple rules, nowadays commonly known as chaos. The field was further developed by leading mathematicians such as Birkhoff (USA), Andronov (Russia), Kolmogorov (Russia), and Cartwright and Littlewood (UK). With the emergence of computers, the field really took off in the 1960s with Russian (Arnold, Moser) and American (Smale) schools leading.

During the last decades the field has established itself as arguably one of the most active areas in mathematics. Its prestige is further illustrated by the awards of Fields Medals for work in the field: Yoccoz (Paris, 1994), McMullen (Harvard, 1998), and Lindenstrauss (Hebrew University, 2010) who used dynamical systems methods to solve problems in number theory, as well as an impressive list of other eminent Field medalists currently active in dynamical systems research (such as Thurston, Milnor, Smale, Bourgain, Tao). Moreover, in 2006, the highly respected Abel Prize was awarded to Carleson (KTH) for fundamental contributions to dynamical systems.

The growth in the field is due in part to the important role that the theory of dynamical systems plays at the interface between mathematics and natural sciences such as physics, chemistry, ecology, meteorology and engineering, amongst others. Many modern developments in applied mathematics involve ideas developed and/or nurtured in dynamical systems.

In recent years and decades important progress has been made to understand the (generic) dynamics of low- dimensional (intrinsically autonomous, i.e. time-independent) dynamical systems, leading to the identification of new challenges, including high-dimensional dynamical systems (including PDEs and other types of functional differential equations), dynamical systems with particular structure (such as Hamiltonian systems, systems with symmetry, and systems on networks), and intrinsically nonautonomous dynamical systems (including dynamical systems with random elements). This joint research programme between Europe and Brazil relies on strong traditions in dynamical systems at both ends, and complementary expertise that will drive innovation and resolve open problems at the forefront of modern dynamical systems research. Typically for the multifaceted field of dynamical systems, the identified work packages have many places of contact among each other, and thus naturally form part of one scientific community, inspiring and challenging each other in many ways.

4.2 Work Packages

Table 1: List of Work Packages

No	Work Package Title	Partners	Start month	End month
1	Nonautonomous Dynamical Systems	EU: Augsburg, Dresden, Imperial, IST, Surrey, UBI, USE, Warwick. BR: UFBA, UFRJ, UNICAMP, USP.	1	48
2	Ergodic Theory	EU: CNRS, Dresden, ICTP, IMPAN, KTH, MLV, Porto,Pisa, StAndrews, Surrey, QMUL. BR: IMPA, PUC-RIO, UFAL, UFBA, UFF, UFRGS, UFRJ, UNICAMP, USP.	1	48
3	Low-Dimensional Dynamics	EU: CNRS, Dresden, Imperial, KTH, Liverpool, Pisa, Surrey, Warwick. BR: IMPA, PUC-RIO, UFBA, UFF, UFRJ, USP.	1	48
4	Hamiltonian Dynamics	EU: CNRS, Imperial, IST, Pisa, UAB, UPC, Warwick. BR: IMPA, UNESP, UFMG, UFRGS, UFRJ, UNICAMP.	1	48
5	Bifurcation Theory	EU: CNRS, Imperial, IST, VUA, Porto, UAB. BR: IMPA, PUC-RIO, UFRJ, UNESP, UNICAMP, USP.	1	48

Work Package 1: Nonautonomous Dynamical Systems

Work Package Number	1	Starting month	1
Beneficiary/Partner	EU: Augsburg, Dresden, Imperial, IST, Surrey, UBI, USE, Warwick. BR: UFBA, UFRJ, UNICAMP, USP.		

Leader: The coordinator for this work package is Imperial.

Objectives:

O1.1 Nonautonomous bifurcation theory. Development of Hopf bifurcation patterns and center manifold theory for non-uniform dichotomies.

O1.2 Attractors in nonautonomous dynamical systems. Development of nonautonomous attractor theory and their bifurcations with application to Morse–Smale evolution processes.

O1.3 Qualitative and geometric properties of stochastic differential equations. Study of the qualitative behaviour of stochastic flows and its bifurcations.

O1.4 Control theory. Development of Lie group theory for flag manifolds with application to invariance entropy; design of algorithms for control problems in robotics.

Description of work:

T1.1 Development of nonautonomous Hopf bifurcation patterns for deterministically forced systems with double skew product structure. Addresses: Research Objective O1.1.

T1.2 Development of a centre manifold theory for nonuniform dichotomies. Addresses: Research Objective O1.1.

T1.3 Detailed description of nonautonomous attractors and its bifurcations for uniformly small Perturb bations of autonomous gradient systems. Addresses: Research Objective O1.2.

T1.4 Characterisation of exponential attractors of Morse–Smale evolution processes. Addresses: Research Objec- tive O1.2.

T1.5 Analysis of open problems for the qualitative behaviour of stochastic flow (mainly for the noncompact case and degenerate diffusions) and related geometric questions such as understanding the Rice type formula for the expected number of fixed points at a given time. Addresses: Research Objective O1.3.

T1.6 Development of a notion of equivalence for n-point Markov processes and development of low-dimensional bifurcation patterns for stochastic differential equations. Addresses: Research Objective O1.3.

T1.7 Proof that control sets have nonpositive escape entropy; this will be used to show that the strict invariance en- tropy is given by the sum of the associated Lyapunov exponents; extension of these results to invariant control systems on semi-simple Lie groups and the induced systems on the generalized flag manifolds. Addresses: Research Objective O1.4.

T1.8 Analysis of criteria for determining which loops in R^3 are liftable to T^N ; description of the space of liftable loops that generate a given rotation, and solutions of optimization problems defined on this space; applications to design of control algorithms and analogous results for other control problems in robotics. Addresses: Research Objective O1.4.

Deliverables:

D1.1 Workshop on Nonautonomous Dynamical Systems. Month: 7.

D1.2 Publication on nonautonomous Hopf bifurcations for deterministically forced systems with double skew prod- uct structure. Month: 48.

D1.3 Publication on uniformly small nonautonomous perturbations of attractors of dynamical systems and its bi- furcation. Month: 48.

D1.4 Publication on qualitative and geometric properties of random dynamical systems. Month: 48.

D1.5 Publication on the relationship between Lyapunov exponents and strict invariance entropy of control systems. Month: 48.

Staff secondments and transfer of knowledge:

Dresden: ER1, ESR2 to UFRJ, working on task T1.1, T1.2, delivering D1.1, D1.2.
UBI: ER3 to UFBA, working on task T1.1, T1.2, delivering D1.1, D1.2.
UFRJ: ER4, ESR5 to Dresden, working on task T1.1, T1.2, delivering D1.1, D1.2.

UFBA: ER6 to UBI, working on task T1.1, T1.2, delivering D1.1, D1.2.
Warwick: ER7 to USP, working on task T1.3, T1.4, delivering D1.1, D1.3.
IST: ER8 to USP, working on task T1.3, T1.4, delivering D1.1, D1.3.
USE: ER9 to USP, working on task T1.3, T1.4, delivering D1.1, D1.3.
USP: ER10 to Warwick, working on task T1.3, T1.4, delivering D1.1, D1.3.
Imperial: ER11, ER12, ESR13, ESR14 to UNICAMP, working on tasks T1.5, T1.6, delivering D1.1, D1.4.
Warwick: ER15. ER16, ER17 to UNICAMP, working on tasks T1.5, T1.6, delivering D1.1, D1.4.
UNICAMP: ER18 to Imperial, working on tasks T1.5, T1.6, delivering D1.1, D1.4.
Surrey: ER19, ESR20 to USP, working on tasks T1.8, delivering D1.1, D1.5.
Augsburg: ER21, ESR22, ESR23 to UNICAMP, working on tasks T1.7, delivering D1.1, D1.5.
USP: ER24, E25, ESR26 to Surrey, working on tasks T1.8, delivering D1.1, D1.5.
UNICAMP: ER27 to Augsburg, working on tasks T1.7, delivering D1.1, D1.5.

Work Package 2: Ergodic Theory

Work Package Number	2	Starting month	1
Beneficiary/Partner	EU: CNRS, Dresden, ICTP, IMPAN, KTH, MLV, Porto, Pisa, StAndrews, Surrey, UBI, QMUL. BR: IMPA, PUC-RIO, UFAL, UFBA, UFF, UFRGS, UFRJ, UNICAMP, USP.		

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Comment [1]: see WP1

Leader: The coordinator for this work package is UFRJ.

Objectives:

O2.1 Phase transitions and ergodic optimization. Detailed understanding of ground states, in particular in terms of the Aubry–Mather sets; development of a theory for fatal phase transitions; detailed understanding of the pressure function.

O2.2 Linear cocycles. Detailed understanding of Lyapunov maximizing measures and the prevalence of sets of matrices whose fastest-growing orbits are periodic or of low symbolic complexity.

O2.3 Non-uniformly hyperbolic systems and their statistical properties. Detailed understanding of statistical properties for non-uniformly expanding maps; applications of spectral techniques to invertible maps with non-uniformly hyperbolic behavior; statistical stability of non-uniformly hyperbolic systems.

O2.4 Partially hyperbolic systems and their statistical properties. Detailed understanding of the dynamics associated with hetero-dimensional cycles; development of the theory for homoclinic classes which lack suitable domination.

O2.5 Flows and their statistical properties. Detailed understanding of statistical properties of (geometric) Lorenz flows, geodesic flows, Anosov flows and star flows.

Description of work:

T2.1 Analysis of the selection process for Lipschitz potentials and uniformly hyperbolic systems. Addresses: Research Objective O2.1.

T2.2 Development of examples of phase transitions for the unstable Jacobian for non-uniformly hyperbolic sys- tems, generic results for the Aubry–Mather set. Addresses: Research Objective O2.1.

T2.3 Analysis of typical properties of Lyapunov maximizing measures, as well as more specific results for cocycles of particular interest. Addresses: Research Objective O2.2.

T2.4 Investigation of the apparent prevalence of fastest-growing products with zero entropy and low symbolic complexity; investigation of the applicability of techniques from the study of joint spectral radii to the in- vestigation of linear cocycles in other contexts; development of results on the apparent prevalence of sets of matrices whose fastest-growing orbits are periodic or of low symbolic complexity. Addresses: Research Objective O2.2.

T2.5 Analysis of the codimension of the subset of input sequences that are not universally regular for generic semilinear systems; application of this type of result to the study of the Lyapunov exponents of linear cocycles over generic conservative dynamical systems. Addresses: Research Objective O2.2.

T2.6 Analysis of Young towers built on adapted functional spaces by using renewal theory. Addresses: Research Objective O2.3.

T2.7 Analysis of stochastic stability for systems with intermittency and Lorenz-like singularities; proof of existence of laws of rare events and convergence of point processes for deterministic and stochastic systems. Addresses: Research Objective O2.3.

T2.8 Analysis of partially hyperbolic systems; topics under consideration are results about Lyapunov exponents, measure of maximal entropy, SRB measures and statistical limit laws such as the central limit theorem. Addresses: Research Objective O2.3.

T2.9 Analysis of the mechanism leading to the generation of homoclinic classes for parameterized families of diffeomorphisms bifurcating via hetero-dimensional cycles, and in the partially hyperbolic case (one-dimensional central bundle). Addresses: Research Objective O2.4.

T2.10 Analysis of results of T2.9 in the special case of cycles associated to skew product dynamics. Addresses: Research Objective O2.4.

T2.11 Analysis of statistical properties of singular hyperbolic attractors for Lorenz-like systems. Addresses: Re- search Objective O2.5.

T2.12 Development of an efficient algorithm to compute the invariant measure (and then several statistical proper- ties) with rigorous bounds on the error for Lorenz-like systems. Addresses: Research Objective O2.5.

T2.13 Proof of the uniqueness of equilibrium states the main families of potentials for the geodesic flow; analysis of their construction as limiting measures of distributions on periodic geodesics. Addresses: Research Objective O2.5.

Deliverables:

D2.1 Workshop on Ergodic Theory. Month: 31.

D2.2 Publication on the selection process for Lipschitz potentials and uniformly hyperbolic systems. Month: 48.

D2.3 Publication on typical properties of Lyapunov maximizing measures. Month: 48.

D2.4 Publication on Young towers built on adapted functional spaces by using renewal theory. Month: 48.

D2.5 Publication on an algorithm to compute invariant measures and several statistical properties for Lorenz-like systems. Month: 48.

Staff secondments and transfer of knowledge:

QMUL: ER28, ESR29 to USP, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
St Andrews: ER30 to UFRJ, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
CNRS: ER31 to UFRGS, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
Dresden: ER1 to PUC-Rio, working on tasks T2.1, T2.2, delivering D2.1, D2.2.

IMPAN: ER32 to UFRJ, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
UFRJ: ER33 to St Andrews, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
UFRJ: ER4 to IMPAN, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
USP: ER34, ER35 to QMUL, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
UFF: ER36 to CNRS, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
UFRGS: ER37 to CNRS, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
UFAL: ER38 to CNRS, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
PUC-Rio: ER39 to IMPAN, working on tasks T2.1, T2.2, delivering D2.1, D2.2.
Surrey: ER40 to PUC-Rio, working on tasks T2.3, T2.4, T2.5, delivering D2.1, D2.3.
QMUL: ER28 to PUC-Rio, working on tasks T2.3, T2.4, T2.5, delivering D2.1, D2.3.
QMUL: ER28 to IMPA, working on tasks T2.3, T2.4, T2.5, delivering D2.1, D2.3.
CNRS: ER41 to PUC-Rio, working on tasks T2.3, T2.4, T2.5, delivering D2.1, D2.3.
IMPA: ER42, ESR43 to QMUL, working on tasks T2.3, T2.4, T2.5, delivering D2.1, D2.3.
PUC-Rio: ER44 to Surrey, working on tasks T2.3, T2.4, T2.5, delivering D2.1, D2.3.
PUC-Rio: ER44 to CNRS, working on tasks T2.3, T2.4, T2.5, delivering D2.1, D2.3.
Warwick: ER45 to USP, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
Warwick: ER45 to UFBA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
Surrey: ESR46 to UFBA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
CNRS: ER47 to USP, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
CNRS: ER47 to UFBA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
CNRS: ER47, ESR48 to IMPA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
CNRS: ER31 to UFF, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
CNRS: ER31 to UFBA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
MLV: ER49 to UNESP, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
MLV: ER49 to UFRJ, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
ICTP: ER50, ESR51 to UFBA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
ICTP: ESR52 to IMPA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
PORTO: ER53, ER54, ER55, ESR56 to IMPA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
KTH: ER57, ER58 to IMPA, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
UFRJ: ER59, ESR60, ER33 to ICTP, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
UFRJ: ER33 to KTH, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
USP: ER61 to Warwick, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
UFF: ER36, ESR62 to ICTP, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
UFBA: ER63 to CNRS, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
UNESP: ER64 to MLV, working on tasks T2.6, T2.7, T2.8, delivering D2.1, D2.4.
CNRS: ER65 to PUC-Rio, working on tasks T2.9, T2.10, delivering D2.1, D2.5.
PORTO: ER53, ER55, ER66 to UFBA, working on tasks T2.9, T2.10, delivering D2.1, D2.5.
UFRJ: ER67 to CNRS, working on tasks T2.9, T2.10, delivering D2.1, D2.5.
USP: ER67 to CNRS, working on tasks T2.9, T2.10, delivering D2.1, D2.5.
UFF: ER36, ER68 to CNRS, working on tasks T2.9, T2.10, delivering D2.1, D2.5.
PUC-Rio: ER44 to CNRS, working on tasks T2.9, T2.10, delivering D2.1, D2.5.
Pisa: ER69, ER70, ESR71 to UFRJ, working on tasks T2.11, T2.12, T2.13, delivering D2.1, D2.5.
Pisa: ER69 to UFBA, working on tasks T2.11, T2.12, T2.13, delivering D2.1, D2.5.
UBI: ER3 to UFRJ, working on tasks T2.11, T2.12, T2.13, delivering D2.1, D2.5.
UFRJ: ER67, ESR72 to Pisa, working on tasks T2.11, T2.12, T2.13, delivering D2.1, D2.5.
UFRJ: ER4, ESR73 to CNRS, working on tasks T2.11, T2.12, T2.13, delivering D2.1, D2.5.
UFBA: ER74 to Pisa, working on tasks T2.11, T2.12, T2.13, delivering D2.1, D2.5.

Work Package 3: Low-Dimensional Dynamics

Work Package Number	3	Starting month	1
Beneficiary/Partner	EU: CNRS, Dresden, Imperial, KTH, Liverpool, Pisa, Surrey, Warwick. BR: IMPA, PUC-RIO, UFBA, UFF, UFRJ, USP.		

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Leader: The coordinator for this work package is Liverpool.

Objectives:

O3.1 Boundary of conservativity in one-dimensional dynamics. Extension of the theory of wild attractors to multi-critical Fibonacci-like interval maps.

O3.2 One-dimensional dynamics and beyond. Extension of classical results in one-dimensional dynamics to higher dimensions.

O3.3 Ergodic properties of one-dimensional dynamical systems. Extension of the thermodynamical formalism to higher dimensions

O3.4 Dimension formulas for general invariant measures. Detailed understanding of fractal dimensions of linear or smooth images of invariant sets.

O3.5 Holomorphic dynamics and continued fractions. Detailed understanding of the dynamics and continued fractions of complex homogeneous vector fields.

O3.6 Dynamics and rotation sets of torus homeomorphisms. Detailed understanding of which subsets of the plane can be realised as rotations sets of torus homeomorphisms.

O3.7 Fixed points for discrete group actions on surfaces. Extensions of well-known results about the existence of common fixed points for Abelian groups of surface diffeomorphisms.

O3.8 Completion of the family of unimodal generalized pseudo-Anosov maps. Construction of a family of quasi-conformal homeomorphisms of the sphere above a one-dimensional family of tent maps.

O3.9 Topological entropy for maps with low regularity in dimension two. Extensions of Katok's Theorem to systems with low regularity.

Description of work:

T3.1 Investigation on the genericity of the existence of wild attractors in the multi-critical setting. Addresses: Research Objective O3.1.

T3.2 Extension of Smania's recent results on renormalisation of multimodal maps building on results on complex bounds by van Strien. Addresses: Research Objective O3.2.

T3.3 Extension of results of Colli and Vargas on the existence of wandering domains for Hénon-like mappings to the real analytic case. Addresses: Research Objective O3.2.

T3.4 Discussion of the existence of wild attractors (similar to those constructed by Bruin, Keller, Nowicki and van Strien) in dimension two. Addresses: Research Objective O3.2.

T3.5 Work on the Palis conjecture, in particular in the one-dimensional case. Addresses: Research Objective O3.2.

T3.6 Extension of the thermodynamic formalism to higher dimensions. Addresses: Research Objective O3.3.

T3.7 Study how the fractal dimensions of products of Gibbs measures associated to non-uniformly expanding maps are affected by linear and nonlinear projections. Addresses: Research Objective O3.4.

T3.8 Analysis of the dynamics of germs tangent to the identity in a full neighbourhood of the origin (at least from a topological point of view and for a generic class of models). Addresses: Research Objective O3.5.

T3.9 Analysis of the dynamics of the geodesic flow of meromorphic connections (in particular when chaos occurs). Addresses: Research Objective O3.5

T3.10 Analysis of the metric theory of continued fractions using kneading theory. Addresses: Research Objective O3.5.

T3.11 Analysis of C^0-genericity of polygonal rotation sets. Addresses: Research Objective O3.6.

T3.12 Studies on the Franks–Misiurewicz conjecture for specific subclasses. Addresses: Research Objective O3.6.

T3.13 Construction of examples of rotation sets with infinitely many accumulations of extreme points. Addresses: Research Objective O3.6.

T3.14 Proof of the existence of two common periodic orbits for pairwise commuting volume-preserving flows near the Hopf fibration. Addresses:Research Objective O3.7.

T3.15 Proof of existence of fixed points for irrational area-preserving Abelian actions on the torus. Addresses: Research Objective O3.7.

T3.16 Generalisations of Cartwright–Littlewood's theorem for group actions. Addresses: Research Objective O3.7.

T3.17 Construction of a family of quasi-conformal homeomorphisms of the sphere above a one-dimensional family of tent maps. Addresses: Research Objective O3.8.

T3.18 Analysis whether Katok's theorem holds for C^1-diffeomorphisms. Addresses: Research Objective O3.9.

T3.19 Analysis of the optimal order of growth for slow entropy ensuring periodic points for C^{1+a}-diffeomorphisms. Addresses: Research Objective O3.9.

Deliverables:

D3.1 Workshop on Low-Dimensional Dynamical Systems. Month: 48

D3.2 Publication on the genericity of the existence of wild attractors in the multi-critical setting. Month: 48

D3.3 Publication on the extension of the thermodynamic formalism to higher dimensions. Month: 48

D3.4 Publication on the C^0-genericity of polygonal rotation sets. Month: 48

D3.5 Publication on generalisations of Cartwright–Littlewood's theorem for group actions. Month: 48

Staff secondments and transfer of knowledge:

Imperial: ER75, ESR80 ER81 to USP, working on tasks T3.1, T3.2, T3.3, T3.4, T.3.5 delivering D3.1, D3.2
Surrey: ER76 to USP, working on tasks T3.1, T3.2, T3.3, T3.4, T.3.5 delivering D3.1, D3.2.
IMPA: ER77 to Imperial, working on tasks T3.1, T3.2, T3.3, T3.4, T.3.5 delivering D3.1, D3.2.
USP: ER78, ER79 to Surrey, working on tasks T3.1, T3.2, T3.3, T3.4, T.3.5 delivering D3.1, D3.2.
USP: ER78, ER79 to Imperial, working on tasks T3.1, T3.2, T3.3, T3.4, T.3.5 delivering D3.1, D3.2.
Imperial: ER75 to UFRJ, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
Surrey: ER76 to UFRJ, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
StAndrews: ER30 to UFBA, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
KTH: ER57, ER58 to UFBA, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
UFRJ: ER33 to KTH, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
UFBA: ER63 to KTH, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
PUC-Rio: ER44 to StAndrews, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
Warwick: ER45 to IMPA, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
Surrey: ER82 to IMPA, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
IMPA: ER83, ESR84 to Surrey, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.

Pisa: ER85, ER86, ER70, ESR87 to IMPA, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
IMPA: ER83, ER88 to Pisa, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
UFRJ: ER67 to Pisa, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
USP: ER89 to Pisa, working on tasks T3.6, T3.7, T3.8, T3.9, T.3.10 delivering D3.1, D3.3.
Liverpool: ER90 to USP, working on tasks T3.11, T3.12, T3.13, T3.14, T.3.15, T3.16 delivering D3.1, D3.4.
Dresden: ER1, ESR91 to USP, working on tasks T3.11, T3.12, T3.13, T3.14, T.3.15, T3.16 delivering D3.1, D3.4.
USP: ER92, ESR94 to Liverpool, working on tasks T3.11, T3.12, T3.13, T3.14, T.3.15, T3.16 delivering D3.1, D3.4.
USP: ER93 to Dresden, working on tasks T3.11, T3.12, T3.13, T3.14, T.3.15, T3.16 delivering D3.1, D3.4.
UFF: ER95 to Dresden, working on tasks T3.11, T3.12, T3.13, T3.14, T.3.15, T3.16 delivering D3.1, D3.4.
USP: ER93, ER96 to CNRS, working on tasks T3.11, T3.12, T3.13, T3.14, T.3.15, T3.16 delivering D3.1, D3.4.
UFF: ER95, ESR96, ER97, ER98 to CNRS, working on tasks T3.11, T3.12, T3.13, T3.14, T.3.15, T3.16 delivering D3.1, D3.4.
Liverpool: ER90 to USP, working on tasks T3.17, T3.18, T3.19 delivering D3.1, D3.5.
USP: ER92 to Liverpool, working on tasks T3.17, T3.18, T3.19 delivering D3.1, D3.5.
Warwick: ER99 to USP, working on tasks T3.17, T3.18, T3.19 delivering D3.1, D3.5.
USP: ER89 to Warwick, working on tasks T3.17, T3.18, T3.19 delivering D3.1, D3.5.

Work Package 4: Hamiltonian Dynamics

Work Package Number	4	Starting month	1
Beneficiary/Partner	EU: CNRS, Imperial, IST, Pisa, UAB, UPC, Warwick. BR: IMPA, UNESP, UFMG, UFRGS, UFRJ, UNICAMP.		

Leader: The coordinator for this work package is UPC.

Objectives:

O4.1 Existence of homoclinic and heteroclinic orbits in families of vector fields. Detailed understanding of the creation of heteroclinic orbits by the nonreversible terms in four-dimensional vector fields.

O4.2 Iterated functions systems in Hamiltonian systems. Detailed understanding of the chaotic behaviour and instabilities of iterated function systems associated to Hamiltonian systems.

O4.3 Perturbations of integrable Hamiltonian systems: stability, instability and applications. Detailed un- derstanding of the qualitative behaviour such as stability of Hamiltonian systems which are close to integrable; application to celestial mechanics.

O4.4 Nonpersistence of resonant caustics in perturbed elliptic billiards. Development of a framework to study the destruction of resonant caustics under specific perturbations of elliptic billiards.

O4.5 Global symplectic invariants of toric symplectic manifolds. Results on the multiplicity of periodic orbits of Reeb flows on a toric contact manifold; detailed understanding of the Langrangian–Floer homology of Langrangian submanifolds.

O4.6 Aubry–Mather theory and mean-field games. Development of sharp estimates for mean-field games based on extensions of Aubry–Mather theory.

O4.7 Hamiltonian dynamics below the Mañ é critical value. Detailed understanding of the existence and multi- plicity of periodic orbits of energies which are below the Mañé critical value.

O4.8 Weak KAM for the Frenkel–Kontorova model. Development of a weak KAM theory for Frenkel– Kontorova models of one-dimensional chains of atoms subjected to a potential arising from a quasicrystal.

Description of work:

T4.1 Construction of a suitable Melnikov vector whose zeros give rise to the surviving homoclinics and also validate it in the case of small amplitude, when the Melnikov function is exponentially small. Addresses: Research Objective O4.1.

T4.2 Study of the heteroclinic orbits created by the nonreversible terms in the vector field by using the theory of normally hyperbolic manifolds and the scattering map. Addresses: Research Objective O4.1.

T4.3 Study of chaos and instabilities by combining scattering maps and iterated function systems. Addresses: Research Objective O4.2.

T4.4 Study of the transition between stability and instability (both in time and in space) for Hamiltonian systems which are close to integrable. Addresses: Research Objective O4.3.

T4.5 Unification of known techniques and development of new techniques to study unstable motions in Hamilto- nian systems. Addresses: Research Objective O4.3.

T4.6 T4.6 Application of the results obtained in T4.4 and T4.5 to realistic problems coming from celestial mechanics. Addresses: Research Objective O4.3.

T4.7 Construction of a large class of explicit perturbations of the original ellipse under which none of the resonant elliptical caustics persists in elliptic billiards. Addresses: Research Objective O4.4.

T4.8 Construction of concrete perturbations of circles (or ellipses) with any given number of periodic trajectories of a selected rotation number. Addresses: Research Objective O4.4.

T4.9 Study of multiplicity of periodic orbits of any Reeb flow on a toric contact manifold. Addresses: Research Objective O4.5.

T4.10 Improvement of recent results concerning the rigidity of Hamiltonian diffeormorphisms on toric symplec- tic manifolds by the study of the Lagrangian Floer homology of certain canonically associated Lagrangian submanifolds. Addresses: Research Objective O4.5.

T4.11 Study of estimates for mean-field games based upon extensions of Aubry–Mather theory which allow to establish new existence, uniqueness, convergence and trend to equilibrium results. Addresses: Research Objective O4.6.

T4.12 Study of the existence and multiplicity of periodic orbits of energies which are below the Mañé critical values; the required tools will include variational minimax arguments and Floer homological methods. Addresses: Research Objective O4.7.

T4.13 Proof of the generic existence of infinitely many closed orbits, at least for systems with two degrees of freedom. Addresses: Research Objective O4.7.

T4.14 Study the relationship of the results developed in T4.12 and T4.13 to symplectic topology. Addresses: Re- search Objective O4.7.

T4.15 Discussion of the graph property of Aubry sets; this will give necessary and sufficient conditions to ensure the existence of a corrector interpreted as a discrete viscosity solution in the same spirit as in Hamilton–Jacobi methods. Addresses: Research Objective O4.8.

Deliverables:

D4.1 Workshop on Hamiltonian Dynamics. Month: 19
D4.2 Publication on heteroclinic orbits created by the nonreversible terms in a four-dimensional vector field. Month: 48
D4.3 Publication on perturbations of the original ellipse under which none of the resonant elliptical caustics persists in elliptic billiards. Month: 48
D4.4 Publication on global symplectic invariants of toric symplectic manifolds. Month: 48
D4.5 Publication on estimates for mean-field games based upon extensions of Aubry–Mather theory. Month: 48
D4.6 Publication on the generic existence of infinitely many closed orbits and weak KAM theory. Month: 48

Staff secondments and transfer of knowledge:

UPC: ER100, ER101, ESR102 to UNICAMP, working on tasks T4.1, T4.2, T4.3, T4.4, T4.5, T4.6 delivering D4.1, D4.2.
UNICAMP: ER103 to UPC, working on tasks T4.1, T4.2, T4.3, T4.4, T4.5, T4.6 delivering D4.1, D4.2.
UPC: ER100, ER104, ESR105 to IMPA, working on tasks T4.1, T4.2, T4.3, T4.4, T4.5, T4.6 delivering D4.1, D4.2.
IMPA: ER106 to UPC, working on tasks T4.1, T4.2, T4.3, T4.4, T4.5, T4.6 delivering D4.1, D4.2.
Warwick: ER107, ESR108 to IMPA, working on tasks T4.1, T4.2, T4.3, T4.4, T4.5, T4.6 delivering D4.1, D4.2.
CNRS: ER109 to IMPA, working on tasks T4.1, T4.2, T4.3, T4.4, T4.5, T4.6 delivering D4.1, D4.2.
IMPA: ER106 to Warwick, working on tasks T4.1, T4.2, T4.3, T4.4, T4.5, T4.6 delivering D4.1, D4.2.
UPC: ER110 to UFMG, working on tasks T4.7, T4.8, delivering D4.1, D4.3.
UFMG: ER111, ER112, ESR112 to UPC, working on tasks T4.7, T4.8, delivering D4.1, D4.3.
IST: ER114 to UFRJ, working on tasks T4.9, T4.10, delivering D4.1, D4.4.
UFRJ: ER115 to IST, working on tasks T4.9, T4.10, delivering D4.1, D4.4.
IST: ER116 to UFRGS, working on tasks T4.11, delivering D4.1, D4.5.
UFRGS: ER117 to IST, working on tasks T4.11, delivering D4.1, D4.5.
Pisa: ER86, ER117 to UFRJ, working on tasks T4.12, T4.13, T4.14, T4.15, delivering D4.1, D4.6.
UFRJ: ER115 to Pisa, working on tasks T4.12, T4.13, T4.14, T4.15, delivering D4.1, D4.6.
CNRS: ER118, ER119, ESR120 to UNICAMP, working on tasks T4.12, T4.13, T4.14, T4.15, delivering D4.1, D4.6.
UNICAMP: ER121 to CNRS, working on tasks T4.12, T4.13, T4.14, T4.15, delivering D4.1, D4.6.

Work Package 5: Bifurcation Theory

Work Package Number	5	Starting month	1
Beneficiary/Partner	EU: CNRS, Dresden, Imperial, IST, VUA, Porto, UAB. BR: IMPA, PUC-RIO, UFRJ, UNESP, UNICAMP, USP.		

Leader: The coordinator for this work package is UAB.

Objectives:

O5.1 Bifurcations via hetero-dimensional cycles. Detailed understanding of the bifurcations which arise due to hetero-dimensional cycles for diffeomorphisms.

- O5.2 Bifurcations in skew product systems. Detailed understanding of bifurcations in skew product flows that are associated with a transversal exchange of stability of an attractive random fixed point.
- O5.3 Periodic orbits and their bifurcations in discontinuous and Hamiltonian differential equations. Development of qualitative methods to study stability and bifurcations of periodic orbits in discontinuous and Hamiltonian differential equations.
- O5.4 Invariant sets in infinite-dimensional systems. Development of a geometric, ergodic and topological theory for invariant sets of infinite-dimensional dynamical systems.
- O5.5 Geometry and number theory. Development of dynamical systems methods for the study of classical problems in number theory.

Description of work:

- T5.1 Analysis of families of diffeomorphisms bifurcating via hetero-dimensional cycles, and in the partially hyper- bolic case (one-dimensional central bundle), study of the mechanism leading to the generation of homoclinic classes. Addresses: Research Objective O5.1.
- T5.2 Construction of a wide class of systems where the creation of infinitely many homoclinic classes (generalized Newhouse phenomenon) cannot occur. Addresses: Research Objective O5.1.
- T5.3 Study of the special case of cycles associated to skew product dynamics in context of the results of T5.1 and T5.2. Addresses: Research Objective O5.1.
- T5.4 Proof of existence and uniqueness of attracting random fixed points. Addresses: Research Objective O5.2. T5.5 Study of bifurcations from attracting random fixed points. Addresses: Research Objective O5.2.
- T5.6 Study of the maximum number of limit cycles for planar discontinuous piecewise linear differential systems defined in two half planes separated by a straight line; in particular, development of a weak version of the Hilbert's 16th problem restricted to this class of differential equations. Addresses: Research Objective O5.3.
- T5.7 Construction of an algorithm that is based on averaging theory to study periodic orbits for Hamilton systems with n degrees of freedom. Addresses: Research Objective O5.3.
- T5.8 Description of geometric, ergodic and topological properties of invariant sets of dynamical systems described by ordinary, partial or functional differential equations in particular using methods of bifurcation theory. Addresses: Research Objective O5.4.
- T5.8 Study of the fractal dimension of all the real numbers x with q-adic complexity bounded by a given function f. Addresses: Research Objective O5.5.
- T5.10 Proof of the fact that homogeneous multi-dimensional continued fraction algorithms are Bernoulli. Ad- dresses: Research Objective O5.5.

Deliverables:

D5.1 Workshop on Bifurcation Theory. Month: 36

D5.2 Publication on bifurcations for diffeomorphisms that arise due to hetero-dimensional cycles. Month: 48

D5.3 Publication on one-dimensional bifurcations of attractive random fixed points. Month: 48

D5.4 Publication on Hilbert's 16th problem restricted to planar discontinuous piecewise linear differential systems. Month: 48

D5.5 Publication on geometric, ergodic and topological properties of invariant sets of dynamical systems described by functional differential equations. Month: 48

D5.6 Publication on higher dimensional continued fraction algorithm. Month: 48.

Staff secondments and transfer of knowledge:
Porto: ER66 to PUC-Rio, working on tasks T5.1, T5.2, T5.3, delivering D5.1, D5.2.
PUC-Rio: ER66 to Porto, working on tasks T5.1, T5.2, T5.3, delivering D5.1, D5.2.
Imperial: ER11 to UFRJ, working on tasks T5.4, T5.5, delivering D5.1, D5.3.
Imperial: ER11 to PUC-Rio, working on tasks T5.4, T5.5, delivering D5.1, D5.3.
VUA: ER122 to UFRJ, working on tasks T5.4, T5.5, delivering D5.1, D5.3.
VUA: ER122 to PUC-Rio, working on tasks T5.4, T5.5, delivering D5.1, D5.3.
Dresden: ER1 to UFRJ, working on tasks T5.4, T5.5, delivering D5.1, D5.3.
UFRJ: ER4 to Imperial, working on tasks T5.4, T5.5, delivering D5.1, D5.3.
PUC-Rio: ER39 to Imperial, working on tasks T5.4, T5.5, delivering D5.1, D5.3.
Imperial: ER11 to UNICAMP, working on tasks T5.6, T5.7, delivering D5.1, D5.4.
UAB: ER123, ER124, ER125 to UNICAMP, working on tasks T5.6, T5.7, delivering D5.1, D5.4.
UNICAMP: ER103 to UAB, working on tasks T5.6, T5.7, delivering D5.1, D5.4.
UNICAMP: ER126, ESR127 to Imperial, working on tasks T5.6, T5.7, delivering D5.1, D5.4.
UNESP: ER128 to Imperial, working on tasks T5.6, T5.7, delivering D5.1, D5.4.
UNESP: ER128, ER129, ER130 to UAB, working on tasks T5.6, T5.7, delivering D5.1, D5.4.
IST: ER8, ER131 to USP, working on tasks T5.8, delivering D5.1, D5.5.
USP: ER10, ER132 to Imperial, working on tasks T5.8, delivering D5.1, D5.5.
CNRS: ER133 to UNICAMP, working on tasks T5.9, T5.10, delivering D5.1, D5.6.
CNRS: ER133, ER135 to IMPA, working on tasks T5.9, T5.10, delivering D5.1, D5.6.
CNRS: ER134 to UNESP, working on tasks T5.9, T5.10, delivering D5.1, D5.6.

Table 2. List and Schedule of Milestones

No	Milestone	WP	Lead	Month	Comments
1	WP 1 Workshop	1	Augsburg	9	
2	New results on geometric properties of control and random dynamical systems	1	Warwick	14	O1.3, O1.4
3	Development of a qualitative theory for infinite-dimensional dynamical systems	5	USP	18	O5.4
4	WP 4 Workshop	4	UAB	19	
5	Detailed understanding of wild attractors and the thermodynamic formalism in higher	3	Imperial	22	O3.2, O3.3
6	IRSES Conference	–	UFRJ	24	
7	New results on perturbed elliptic billiards	4	UPC	26	O4.4
8	Detailed understanding of statistical properties of non-uniform and partially hyperbolic systems	2	ICTP	30	O2.3, O2.4
9	WP 5 Workshop	5	USP	32	
10	WP 2 Workshop	2	CNRS	32	
11	New results on continued fractions in holomorphic dynamics	3	IMPA	34	O3.5
12	Development of a weak KAM theory	4	CNRS	38	O4.8
13	WP 3 Workshop	3	UFBA	42	
14	Progress in nonautonomous bifurcation theory	1	Imperial	42	O1.1, O1.2, O1.3
15	Advances at the intersection of dynamical systems and number theory	5	UNICAMP	46	O5.5
16	Detailed understanding of fatal phase transitions	2	UFRJ	48	O2.1, O2.2
17	IRSES Conference	–	Imperial	48	

Table 3: Gantt chart of secondments (Table A.3.4 from the GPF)

PARTICIPANT NUMBER	ORIGIN PARTNER	ORIGIN COUNTRY	HOST PARTNER	HOST COUNTRY	SECONDED TYPE	DURATION (MONTHS)	STARTING MONTH	1												2												3												4											
								1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
								1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	Imperial	UK	UNICAMP	BR	ER1	1	4				■																																												
1	Imperial	UK	UNICAMP	BR	ER1	1	23																								■																									
1	Imperial	UK	UNICAMP	BR	ER1	1	36																																				■												
1	Imperial	UK	UNICAMP	BR	ER1	1	48																																																■
1	Imperial	UK	UNICAMP	BR	ER2	1	31																															■																	
1	Imperial	UK	UNICAMP	BR	ESR1	1	4				■																																												
1	Imperial	UK	UNICAMP	BR	ESR1	1	23																								■																									
1	Imperial	UK	UNICAMP	BR	ESR1	1	36																																				■												
1	Imperial	UK	UNICAMP	BR	ESR1	1	48																																																■
1	Imperial	UK	UNICAMP	BR	ESR2	1	12												■																																				
1	Imperial	UK	UNICAMP	BR	ESR2	1	19																				■																													
1	Imperial	UK	UNICAMP	BR	ESR2	1	31																															■																	
1	Imperial	UK	UNICAMP	BR	ESR2	1	48																																																■
1	Imperial	UK	USP	BR	ER3	1	5					■																																											
1	Imperial	UK	USP	BR	ER3	1	19																				■																													
1	Imperial	UK	IMPA	BR	ER3	1	14														■																																		
1	Imperial	UK	IMPA	BR	ER3	1	37																																					■											
1	Imperial	UK	IMPA	BR	ESR3	1	14														■																																		
1	Imperial	UK	IMPA	BR	ER4	1	25																									■																							
1	Imperial	UK	UFRJ	BR	ER3	1	21																						■																											
1	Imperial	UK	UFRJ	BR	ER1	1	29																													■																			
1	Imperial	UK	PUC-RIO	BR	ER1	1	41																																									■							
1	Imperial	UK	UNICAMP	BR	ER1	1	10										■																																						
1	Imperial	UK	UNICAMP	BR	ER1	1	28																												■																				
1	Imperial	UK	IMPA	BR	ESR1	1	13													■																																			
1	Imperial	UK	IMPA	BR	ESR1	1	14														■																																		
2	Warwick	UK	USP	BR	ER5	1	19																				■																													
2	Warwick	UK	USP	BR	ER5	1	31																															■																	
2	Warwick	UK	UNICAMP	BR	ER6	1	20																					■																												
2	Warwick	UK	UNICAMP	BR	ER7	1	32																																■																
2	Warwick	UK	UNICAMP	BR	ER8	1	9									■																																							
2	Warwick	UK	USP	BR	ER9	1	1	■																																															
2	Warwick	UK	USP	BR	ER9	1	25																									■																							
2	Warwick	UK	IMPA	BR	ER10	1	11											■																																					
2	Warwick	UK	IMPA	BR	ESR4	1	35																																			■													
2	Warwick	UK	USP	BR	ER11	1	11											■																																					
2	Warwick	UK	UFBA	BR	ER11	1	23																								■																									
2	Warwick	UK	UFBA	BR	ER11	1	35																																			■													
2	Warwick	UK	IMPA	BR	ER11	1	13													■																																			
2	Warwick	UK	IMPA	BR	ER11	1	47																																															■	
3	Liverpool	UK	USP	BR	ER12	2	1	■	■																																														
3	Liverpool	UK	USP	BR	ER12	1	16																■																																
3	Liverpool	UK	USP	BR	ER12	3	4				■	■	■																																										
3	Liverpool	UK	IMPA	BR	ER12	1	13													■																																			

4	Surrey	UK	USP	BR	ER13	1	19
4	Surrey	UK	USP	BR	ER13	1	31
4	Surrey	UK	USP	BR	ESR5	1	19
4	Surrey	UK	USP	BR	ESR5	1	31
4	Surrey	UK	PUC-RIO	BR	ER14	1	8
4	Surrey	UK	PUC-RIO	BR	ER14	1	32
4	Surrey	UK	UFBA	BR	ESR6	1	23
4	Surrey	UK	UFBA	BR	ESR6	1	35
4	Surrey	UK	USP	BR	ER15	1	6
4	Surrey	UK	USP	BR	ER15	1	28
4	Surrey	UK	UFRJ	BR	ER15	1	7
4	Surrey	UK	IMPA	BR	ER16	1	1
4	Surrey	UK	IMPA	BR	ER16	1	25
5	QMUL	UK	USP	BR	ER17	1	7
5	QMUL	UK	USP	BR	ER17	1	20
5	QMUL	UK	USP	BR	ESR7	1	7
5	QMUL	UK	PUC-RIO	BR	ER17	1	18
5	QMUL	UK	IMPA	BR	ER17	1	44
5	QMUL	UK	IMPA	BR	ER17	1	13
6	StAndrews	UK	UFRJ	BR	ER18	1	41
6	StAndrews	UK	UFBA	BR	ER18	1	19
6	StAndrews	UK	IMPA	BR	ER18	1	13
7	VUA	NL	UFRJ	BR	ER19	1	6
7	VUA	NL	PUC-RIO	BR	ER19	1	7
7	VUA	NL	IMPA	BR	ER19	1	13
8	CNRS	FR	UFRGS	BR	ER20	1	17
8	CNRS	FR	UFRGS	BR	ER20	1	37
8	CNRS	FR	PUC-RIO	BR	ER21	1	2
8	CNRS	FR	PUC-RIO	BR	ER21	1	38
8	CNRS	FR	USP	BR	ER22	1	6
8	CNRS	FR	UFBA	BR	ER22	1	16
8	CNRS	FR	IMPA	BR	ER22	1	28
8	CNRS	FR	IMPA	BR	ESR8	1	28
8	CNRS	FR	UFF	BR	ER20	1	2
8	CNRS	FR	UFF	BR	ER20	1	14
8	CNRS	FR	UFBA	BR	ER20	1	3
8	CNRS	FR	UFBA	BR	ER20	1	27
8	CNRS	FR	PUC-RIO	BR	ER23	1	2
8	CNRS	FR	PUC-RIO	BR	ER23	1	26
8	CNRS	FR	IMPA	BR	ER24	1	31
8	CNRS	FR	UNICAMP	BR	ER25	1	25
8	CNRS	FR	UNICAMP	BR	ER25	1	37
8	CNRS	FR	UNICAMP	BR	ER26	1	9
8	CNRS	FR	UNICAMP	BR	ER26	1	21
8	CNRS	FR	UNICAMP	BR	ESR9	1	9
8	CNRS	FR	UNICAMP	BR	ESR9	1	21
8	CNRS	FR	UNICAMP	BR	ER27	2	17
8	CNRS	FR	IMPA	BR	ER27	1	26
8	CNRS	FR	IMPA	BR	ER28	1	21
8	CNRS	FR	IMPA	BR	ER28	1	45
8	CNRS	FR	UNESP	BR	ER29	1	6
8	CNRS	FR	UNESP	BR	ER29	1	31
8	CNRS	FR	IMPA	BR	ESR9	1	13
8	CNRS	FR	IMPA	BR	ESR8	1	13
8	CNRS	FR	IMPA	BR	ER22	1	13

9	UPEMLV	FR	UNESP	BR	ER30	1	27
9	UPEMLV	FR	UFRJ	BR	ER30	1	3
9	UPEMLV	FR	IMPA	BR	ER30	1	13
10	Augsburg	DE	UNICAMP	BR	ER31	1	26
10	Augsburg	DE	UNICAMP	BR	ESR10	2	17
10	Augsburg	DE	UNICAMP	BR	ESR11	2	26
10	Augsburg	DE	IMPA	BR	ESR10	1	13
11	Dresden	DE	UFRJ	BR	ER32	1	28
11	Dresden	DE	UFRJ	BR	ESR12	1	28
11	Dresden	DE	PUC-RIO	BR	ER32	1	32
11	Dresden	DE	USP	BR	ER32	1	20
11	Dresden	DE	USP	BR	ESR13	1	20
11	Dresden	DE	UFRJ	BR	ER32	1	24
11	Dresden	DE	IMPA	BR	ESR13	1	13
12	Pisa	IT	UFRJ	BR	ER33	1	4
12	Pisa	IT	UFRJ	BR	ER33	1	14
12	Pisa	IT	UFRJ	BR	ER34	1	26
12	Pisa	IT	UFRJ	BR	ESR14	1	4
12	Pisa	IT	UFRJ	BR	ESR14	1	14
12	Pisa	IT	UFBA	BR	ER33	1	37
12	Pisa	IT	IMPA	BR	ER35	2	5
12	Pisa	IT	IMPA	BR	ER36	1	5
12	Pisa	IT	IMPA	BR	ER36	1	23
12	Pisa	IT	IMPA	BR	ER34	1	11
12	Pisa	IT	IMPA	BR	ESR15	1	11
12	Pisa	IT	IMPA	BR	ESR15	1	38
12	Pisa	IT	UFRJ	BR	ER36	1	7
12	Pisa	IT	UFRJ	BR	ER37	1	30
12	Pisa	IT	IMPA	BR	ESR15	1	13
12	Pisa	IT	IMPA	BR	ESR14	1	13
13	NESCO-ICTI	FR	UFBA	BR	ER38	1	7
13	NESCO-ICTI	FR	UFBA	BR	ER38	1	33
13	NESCO-ICTI	FR	UFBA	BR	ESR16	2	7
13	NESCO-ICTI	FR	UFBA	BR	ESR16	2	33
13	NESCO-ICTI	FR	IMPA	BR	ESR17	2	14
13	NESCO-ICTI	FR	IMPA	BR	ESR17	2	25
13	NESCO-ICTI	FR	IMPA	BR	ESR17	1	13
14	Porto	PT	IMPA	BR	ER39	1	19
14	Porto	PT	IMPA	BR	ER40	1	19
14	Porto	PT	IMPA	BR	ER41	1	33
14	Porto	PT	UFBA	BR	ESR18	1	33
14	Porto	PT	UFBA	BR	ER39	1	4
14	Porto	PT	UFBA	BR	ER41	1	19
14	Porto	PT	PUC-RIO	BR	ER42	1	36
14	Porto	PT	IMPA	BR	ER42	1	39
14	Porto	PT	IMPA	BR	ESR18	1	13
15	UBI	PT	UFBA	BR	ER43	1	42
15	UBI	PT	UFRJ	BR	ER43	1	32
15	UBI	PT	IMPA	BR	ER43	1	13
16	IST	PT	USP	BR	ER44	1	16
16	IST	PT	UFRJ	BR	ER45	1	30
16	IST	PT	UFRGS	BR	ER46	1	20
16	IST	PT	USP	BR	ER44	1	6
16	IST	PT	USP	BR	ER44	1	19
16	IST	PT	USP	BR	ER47	1	12
16	IST	PT	USP	BR	ER47	1	35
16	IST	PT	IMPA	BR	ER44	1	13

17	UAB	ES	UNICAMP	BR	ER48	1	19
17	UAB	ES	UNICAMP	BR	ER48	1	32
17	UAB	ES	UNICAMP	BR	ER49	2	1
17	UAB	ES	UNICAMP	BR	ER49	1	24
17	UAB	ES	UNICAMP	BR	ER49	1	44
17	UAB	ES	UNICAMP	BR	ER50	1	18
17	UAB	ES	UNICAMP	BR	ER50	1	41
17	UAB	ES	IMPA	BR	ER50	1	13
18	UPC	ES	UNICAMP	BR	ER51	1	2
18	UPC	ES	UNICAMP	BR	ER51	1	30
18	UPC	ES	UNICAMP	BR	ER51	1	11
18	UPC	ES	UNICAMP	BR	ER52	1	34
18	UPC	ES	UNICAMP	BR	ESR19	1	11
18	UPC	ES	UNICAMP	BR	ESR19	1	34
18	UPC	ES	IMPA	BR	ER53	1	25
18	UPC	ES	IMPA	BR	ER51	1	33
18	UPC	ES	IMPA	BR	ESR20	1	14
18	UPC	ES	UFMG	BR	ER54	1	1
18	UPC	ES	UFMG	BR	ER54	1	25
18	UPC	ES	UFMG	BR	ER54	1	36
18	UPC	ES	IMPA	BR	ESR20	1	13
18	UPC	ES	IMPA	BR	ESR19	1	13
19	USE	ES	USP	BR	ER55	1	5
19	USE	ES	USP	BR	ER55	1	32
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20	IMPAN	PL	UFRJ	BR	ER56	1	7
20	IMPAN	PL	UFRJ	BR	ER56	1	37
20	IMPAN	PL	IMPA	BR	ER56	1	13
21	KTH	SE	IMPA	BR	ER57	1	7
21	KTH	SE	IMPA	BR	ER57	1	32
21	KTH	SE	IMPA	BR	ER58	1	20
21	KTH	SE	IMPA	BR	ER58	1	37
21	KTH	SE	UFBA	BR	ER58	1	4
21	KTH	SE	UFBA	BR	ER57	1	20
21	KTH	SE	IMPA	BR	ER57	1	13
22	UFRJ	BR	Imperial	UK	ER59	1	26
22	UFRJ	BR	Imperial	UK	ESR21	1	43
22	UFRJ	BR	Imperial	UK	ESR22	1	43
22	UFRJ	BR	StAndrews	UK	ER60	1	24
22	UFRJ	BR	CNRS	FR	ER61	1	25
22	UFRJ	BR	CNRS	FR	ER59	1	12
22	UFRJ	BR	CNRS	CNRS	ER59	1	24
22	UFRJ	BR	CNRS	CNRS	ESR21	1	24
22	UFRJ	BR	Dresden	DE	ER59	1	14
22	UFRJ	BR	Dresden	DE	ER59	1	37
22	UFRJ	BR	Dresden	DE	ESR22	1	14
22	UFRJ	BR	Dresden	DE	ESR22	1	37
22	UFRJ	BR	Pisa	IT	ER61	1	26
22	UFRJ	BR	Pisa	IT	ER61	1	36
22	UFRJ	BR	Pisa	IT	ESR23	1	26
22	UFRJ	BR	Pisa	IT	ESR23	1	36
22	UFRJ	BR	Pisa	IT	ER61	1	8
22	UFRJ	BR	Pisa	IT	ER62	1	20
22	UFRJ	BR	INESCO-ICT	FR	ER63	1	1
22	UFRJ	BR	INESCO-ICT	FR	ER63	1	14
22	UFRJ	BR	INESCO-ICT	FR	ESR24	1	1
22	UFRJ	BR	INESCO-ICT	FR	ER60	1	14
22	UFRJ	BR	IST	PT	ER62	1	48
22	UFRJ	BR	IMPAN	PL	ER59	1	14
22	UFRJ	BR	IMPAN	PL	ER59	1	48
22	UFRJ	BR	KTH	SE	ER60	1	25
22	UFRJ	BR	KTH	SE	ER60	1	14

23	IMPA	BR	Imperial	UK	ER64	1	24
23	IMPA	BR	Imperial	UK	ER64	1	42
23	IMPA	BR	Imperial	UK	ESR25	1	43
23	IMPA	BR	Warwick	UK	ER65	1	37
23	IMPA	BR	Surrey	UK	ER66	1	24
23	IMPA	BR	Surrey	UK	ESR25	2	11
23	IMPA	BR	QMUL	UK	ER67	1	32
23	IMPA	BR	QMUL	UK	ESR26	1	32
23	IMPA	BR	Pisa	IT	ER68	1	8
23	IMPA	BR	Pisa	IT	ER68	1	36
23	IMPA	BR	Pisa	IT	ER66	1	24
23	IMPA	BR	UPC	ES	ER65	1	24
24	USP	BR	Imperial	UK	ER69	1	26
24	USP	BR	Imperial	UK	ER69	1	38
24	USP	BR	Imperial	UK	ER70	1	14
24	USP	BR	Imperial	UK	ER70	1	35
24	USP	BR	Imperial	UK	ESR28	1	43
24	USP	BR	Imperial	UK	ER71	1	43
24	USP	BR	Imperial	UK	ER73	1	43
24	USP	BR	Warwick	UK	ER72	1	26
24	USP	BR	Warwick	UK	ER74	1	19
24	USP	BR	Warwick	UK	ER74	1	41
24	USP	BR	Warwick	UK	ER75	1	12
24	USP	BR	Liverpool	UK	ER71	1	18
24	USP	BR	Liverpool	UK	ER71	1	30
24	USP	BR	Liverpool	UK	ER73	1	18
24	USP	BR	Liverpool	UK	ER71	1	24
24	USP	BR	Liverpool	UK	ER71	2	37
24	USP	BR	Surrey	UK	ER76	1	24
24	USP	BR	Surrey	UK	ER77	1	36
24	USP	BR	Surrey	UK	ESR27	1	24
24	USP	BR	Surrey	UK	ESR27	1	36
24	USP	BR	Surrey	UK	ER69	1	14
24	USP	BR	Surrey	UK	ER70	1	25
24	USP	BR	QMUL	UK	ER78	1	25
24	USP	BR	QMUL	UK	ER79	1	37
24	USP	BR	CNRS	FR	ER75	1	1
24	USP	BR	CNRS	FR	ER75	1	14
24	USP	BR	CNRS	FR	ER80	1	24
24	USP	BR	CNRS	FR	ER81	1	37
24	USP	BR	Dresden	DE	ER81	1	12
24	USP	BR	Pisa	IT	ER74	1	26
24	USP	BR	IST	PT	ER72	1	29
24	USP	BR	IST	PT	ER82	1	40

25	UFF	BR	Imperial	UK	ESR28	1	43
25	UFF	BR	Imperial	UK	ESR29	1	43
25	UFF	BR	CNRS	FR	ER83	1	6
25	UFF	BR	CNRS	FR	ER83	1	30
25	UFF	BR	CNRS	FR	ER84	1	24
25	UFF	BR	CNRS	FR	ER84	1	36
25	UFF	BR	CNRS	FR	ER85	1	6
25	UFF	BR	CNRS	FR	ER86	1	25
25	UFF	BR	CNRS	FR	ER87	1	47
25	UFF	BR	CNRS	FR	ESR28	1	25
25	UFF	BR	Dresden	DE	ER87	1	25
25	UFF	BR	NESCO-ICT	FR	ER83	1	18
25	UFF	BR	NESCO-ICT	FR	ESR29	1	18
25	UFF	BR	NESCO-ICT	FR	ESR29	1	32
26	UFBA	BR	Imperial	FR	ER88	1	43
26	UFBA	BR	CNRS	FR	ER88	1	26
26	UFBA	BR	Pisa	IT	ER89	1	34
26	UFBA	BR	Pisa	IT	ER90	1	48
26	UFBA	BR	UBI	PT	ER90	1	24
26	UFBA	BR	KTH	SE	ER88	1	25
27	UNICAMP	BR	Imperial	UK	ER91	1	24
27	UNICAMP	BR	Imperial	UK	ER92	1	29
27	UNICAMP	BR	Imperial	UK	ER92	1	46
27	UNICAMP	BR	Imperial	UK	ESR30	1	9
27	UNICAMP	BR	Imperial	UK	ESR30	1	39
27	UNICAMP	BR	Imperial	UK	ER93	1	43
27	UNICAMP	BR	CNRS	FR	ER94	1	14
27	UNICAMP	BR	CNRS	FR	ER94	1	36
27	UNICAMP	BR	Augsburg	DE	ER95	1	37
27	UNICAMP	BR	UAB	ES	ER93	1	6
27	UNICAMP	BR	UAB	ES	ER93	1	21
27	UNICAMP	BR	UPC	ES	ER93	1	15
28	UFRGS	BR	Imperial	UK	ER96	1	43
28	UFRGS	BR	CNRS	FR	ER96	1	12
28	UFRGS	BR	IST	PT	ER96	1	1
29	UFAL	BR	Imperial	UK	ER97	1	43
29	UFAL	BR	CNRS	FR	ER97	1	1
29	UFAL	BR	CNRS	FR	ER97	1	14
30	UNESP	BR	Imperial	UK	ER98	1	25
30	UNESP	BR	Imperial	UK	ER99	1	43
30	UNESP	BR	UPEMLV	FR	ER99	1	14
30	UNESP	BR	UAB	ES	ER98	1	37
30	UNESP	BR	UAB	ES	ER100	1	8
30	UNESP	BR	UAB	ES	ER101	1	11
30	UNESP	BR	UAB	ES	ER101	1	35
31	PUC-RIO	BR	Imperial	UK	ER102	1	37
31	PUC-RIO	BR	Imperial	UK	ER102	1	43
31	PUC-RIO	BR	Surrey	UK	ER103	1	1
31	PUC-RIO	BR	Surrey	UK	ER103	1	14
31	PUC-RIO	BR	StAndrews	UK	ER103	1	11
31	PUC-RIO	BR	CNRS	FR	ER103	1	25
31	PUC-RIO	BR	CNRS	FR	ER103	1	27
31	PUC-RIO	BR	Porto	PT	ER102	1	2
31	PUC-RIO	BR	Porto	PT	ER102	1	37
31	PUC-RIO	BR	Porto	PT	ER102	1	25
31	PUC-RIO	BR	IMPAN	PL	ER102	1	24
31	PUC-RIO	BR	IMPAN	PL	ER102	1	37
32	UFMG	BR	Imperial	UK	ESR31	1	43
32	UFMG	BR	UPC	ES	ER104	1	34
32	UFMG	BR	UPC	ES	ER105	1	7
32	UFMG	BR	UPC	ES	ESR31	1	7

5. Project management

5.1 Network organization and management structure

5.1.1 Organisational structure

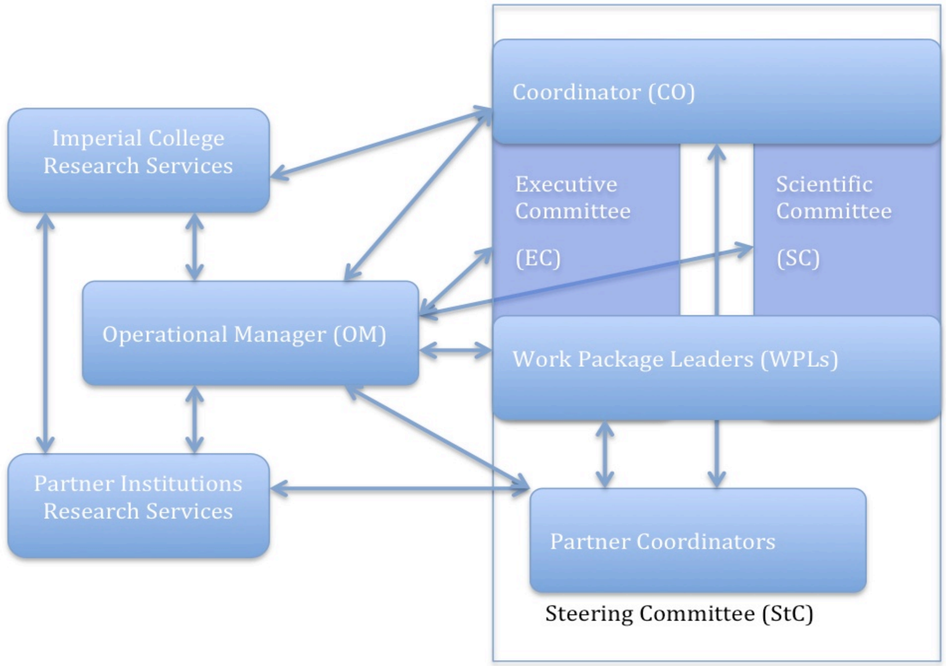

Figure 1. Management structure of the IRSES project.

The network management structure will be divided into network-wide and local levels. The overall responsibility for the management rests with the network coordinator (CO), who chairs the Steering Committee (StC).

The Operational Manager (OM) and Network Office. The CO is responsible for all management tasks according to the IRSES rules, for the cooperation with the European Commission, for the scientific orientation and quality of the network. The network coordinator will be in continuous contact with the members of the Steering Committee, calls meetings of the Steering Committee and chairs them.

The CO is assisted by an Operational Manager (OM), who will be appointed part-time and whose duties include:

- Running the network office.
- To coordinate and initiate contact between partners.
- To create and maintain a webpage to distribute information and preprints.
- Publication of a network bulletin, providing information about scientific events and new scientific

results from the network to be distributed to all partners.

- To encourage and arrange dissemination of results, lecture notes and proceedings of workshops and conferences. This is done through reports of the team leaders, and provides the basis for a preprint series and subsequent publications (even lecture notes and surveys).
- To monitor that network activities are compliant with contractual obligations.
- To ensure that proper financial management and control is kept on the project, including audit certification.

Steering Committee The Steering Committee (StC), consists of the CO, all the scientific coordinators of the network partners and a small number of senior researchers from the network. It decides annually on issues concerning the scientific and organisational plan of the IRSES. It decides about the annual budget and distribution of funds, within the contract with the EC.

To assist the StC and the CO the following subcommittees of the StC will be put in place:

- An Executive Committee (EC), which assists the CO in all major decisions throughout the year, and is respon- sible for initiating and monitoring network activities. It consists of the CO, Work Package Leaders, and a small number of additional senior scientists, with the OM in an overall assisting and advising role. It communicates mainly by e-mail, phone, or teleconference.
- A Scientific Committee (SC), to monitor the research programme, to draft annual scientific reports, and to advise the StC of actions which might need to be taken in the light of changing circumstances.

Yearly, with the benefit of input from the EC and SC, the StC discusses and decides on:

- Progress towards the scientific objectives and milestones.
- Topics/programmes and appointments of organisers for conferences and workshops.
- The annual financial report (from OM and CO), and fair redistribution of funds.
- Actions which might need to be taken in the light of changing circumstances.

As is illustrated in Figure 1, the OM is to occupy a pivotal bridge between the CO, EC and Local organisation at partner level. At each partner, the local scientific coordinator takes care of the practical organisation in relation to staff exchanges, like local administration (in particular, to arrange for the relevant paperwork that records staff exchanges in the role of home or host) and to secure smooth integration with the host for visiting seconded researchers.

5.1.2 Coordination and decision making process:

At the network-wide level the local needs will be represented by the partner scientific coordinators; their responsibilities will consist of ensuring progress towards the local tasks, reporting to the SC about secondments taken place at the local partner, and the provision of scientific contributions by the partner at the relevant conferences and workshops.

5.1.3 Communication method:

The Steering Committee (StC) discusses once a year, normally by e-mail. The Executive Committee (EC) communicates more frequently, mainly by e-mail or by phone or teleconference. The network will set-up a website and other facilities for the distribution of preprints.

5.1.4 Task delegation policy:

The CO and OM monitor the way budgets are spent, progress of secondments, planning of local events, and so on, and if necessary offer support to partners at a local level. The OM acts as first point of contact if difficulties arise.

5.1.5 Monitoring and reporting procedures:

The EC and OM will make sure that there are regular reports from seconded ERs/ESRs, local scientific coordinators and WPLs. If there are short-comings, the Executive Committee, and in some cases the Scientific Committee will be asked for advise.

5.1.6 Dissemination of research policy:

The policy will be to publish all results obtained through the network in peer reviewed international journals, and preliminary results should appear as preprints and so on. The network will set-up a website and other facilities for the distribution of preprints.

5.1. Reporting:

The seconded ESR's and ER's will be required to report on their work, annually or after the end of each secondment, to the relevant Work Package leaders and local partner coordinators, who will report these to the OM. Annually WPLs report to the SC, which in turn produces a yearly progress report for the StC.

5.2 Financial management:

The financial management of the grant will be coordinated by the CO in close collaboration with Imperial College Research Services, and aided by the OM. Imperial College Research Services will coordinate the allocation of funds to the European network partners (to fund outgoing and incoming missions, as planned in the schedule of secondments). Imperial College Research Services closely collaborates with CO and OM to support their management and monitoring of the network's finances.

Distribution of funds:

The steering committee can redistribute funds, if this is appropriate, and will discuss the eventual necessity in each annual Steering Committee meeting, where updates of the schedule of secondments will be discussed. The REA will be informed if major changes occur. In addition, change in the schedule of secondments will be specified in the report, to be submitted according to the GA provisions. A small proportion of the funds (to be specified in the partnership agreement) will be reserved for the salary of the OM, and management-related expenses of the OM and CO.

5.3 Secondment strategy:

A detailed schedule of secondments is presented in Table 3. Minor amendments to this schedule are to be communicated by the seconded ER/ESR to the relevant WPL, involved partner scientific coordinators, and OM. WPLs should normally authorise such amendments or refer them to OM/CO for authorization. Yearly, the secondment allocations and schedule are reviewed by EC and SC, and where needed the StC can decide to a redistribution and reschedule of secondments. Researcher Registration Reports (RRR) will be submit to EC via SESAM, according to the Annex III of the GA.

5.4 Intellectual property:

Jointly-owned IP and rights to its use will be detailed in the partnership agreement, as well as terms related to Access Rights to Foreground and Background and ownership of work carried out by a Researcher on secondment. The provisions will be in line with the general provisions in Annex II of the GA.

6 Impact

6.1 Relevance of the proposed partnership to the area of collaboration and for the ERA

6.1.1 Partnership's contribution to area of collaboration

Dynamical systems is a well-established modern field in mathematics, motivated by an abundance of applications in natural sciences areas such as physics, chemistry, ecology, meteorology and engineering, but increasingly also in the social sciences, including for instance economy and sociology. Research in dynamical systems is traditionally very strong in the European Union, and it is a key technological interest of the European Union to lead in this area. Brazilian mathematics is renowned for its strength in Dynamical Systems. Indeed this field dominates in Brazil, with strong support through its National Institute of Pure and Applied Mathematics (IMPA) in Rio de Janeiro, and achieved over the last 30 years various positions of world-leadership in the development of the field. The partnership of European and Brazilian researchers in this proposal represents a substantial part of the world leading strength in this field, with strength complementary to this project mainly in the USA. The project addresses central research problems in the field, and the impact of this project will be noticable world-wide.

While dynamical systems research centered around Europe and Russia in the first half of the twentieth century, leading groups are currently located in the European Union, the USA, and Brazil. In comparison to the European Union, Brazil's research in dynamical systems is more specialised, which is partially because of the smaller size of the community, but also due to the fact that the European Union represents many different countries, each with their own priorities and attitudes to research. Dynamical systems research in Brazil is world-leading, not a minor achievement for a country where infrastructure in science and mathematics were developed seriously only since the 1950s, and the joint European and Brazilian research effort would cover approximately 70% of the world-leading research in this field.

Among the partners in this IRSES project we identify some leading regional collaborative groupings that form the backbone of the proposed partnership, complemented with some more isolated smaller partners in other regions. For instance, the research groups of Imperial College, Surrey, and QMUL in London already cooperate in the context of the London Dynamical Systems Group and have close relations with the renowned centre of excellence in dynamical systems at the University of Warwick. Similarly, the dynamical systems groups at UAB and UPC cooperate closely already in Barcelona. French activity in dynamical systems is focussed in several CNRS institutes, with particular concentration around Paris. In Brazil, we identify two main groupings. In Rio de Janeiro, IMPA, UFF, PUC-RIO and UFRJ collaborate closely in dynamical systems (with the joint seminar series EDAI, for instance) , and the groups at UFBA, UFAL also liaise closely with this group. The São Paulo universities, USP, UNICAMP and UNESP form another cluster with close collaborations.

The majority of world-leading European and Brazilian researchers in dynamical systems are participants to the pro- posed staff exchange scheme (see Section 1.3). The annual IRSES meetings and WP-specific workshops, that are open also to researchers outside the IRSES, will be among the leading events in the field during the course of the project.

6.1.2 Relevance of the exchange between the partner countries for ERA

This proposed staff exchange programme will have a sizeable impact on the following objectives of the European Research Area.

Strategic interest in scientific cooperation with Brazil. Brazil with its population of 180 million is by far the most populous country in Latin America and represents the second most populated country of the Americas after the USA. Brazilian scientific research and economy are currently thriving, and it is a recognised key strategic interest of the European Union to scientifically cooperate with Brazil as set out in the Agreement on scientific and technological cooperation (ratified by the European Union in 2005 and by Brazil in January 2007), and recently reiterated in the Communication "EU-Latin America: Global players in Partnership", COM(2009) 495/3, with emphasis on the need for strengthening cooperation in knowledge and innovation-related areas such as research/higher education, science, technology, and renewable energy. The proposed partnership involves the leading Brazilian universities and researchers in mathematics and will have a decisive impact to promote this agreement.

Greater mobility for European researchers in Europe and an introduction of a European dimension into scientific careers. The proposed partnership concerns exchanges between Europe and Brazil, but due to the extensive participation of different European partners, it indirectly also serves as a catalyser for mobility of European researchers who through this project will have increased incentives to work together (with Brazilians and other Europeans) on joint projects. The proposed bi-annual IRSES conferences and the WP-specific workshops will further facilitate the interaction between European partners, also benefitting European researchers that do not take part in this IRSES project. Experience with other Europe wide research and training networks in dynamical systems is that the dynamical systems community reacts very positively to such stimulus.

Greater place and role for women in research

The overall participation level of women versus men in this project is much lower than we would like but commensurate to that in the community. The IRSES will make it an explicit policy to stimulate the participation of women in the staff exchanges and meetings, especially at early career level.

Giving young people a taste for research and careers in science:

This staff exchange program involves senior and junior researchers, and the large amount of PhD students and postdocs involved in the different projects shows that junior researchers will be crucial for the successful implementation of the projects. Apart from being involved directly, lots of training opportunities for young researchers will be provided, through the graduate schools, the WP- specific workshops, locally run mini-courses and seminars. In addition to this, junior exchange staff will be able and encouraged to attend postgraduate courses at the host institution. The major hosts in this exchange programme have a critical mass in the field of dynamical systems and offer a variety of advanced courses at postgraduate level, mostly already taught in English, very well suitable for postdocs and PhD students involved in exchanges. Moreover, the annual IRSES conference will give young researchers the opportunity to present their own research and to build new scientific collaborations.

Greater role of the regions in the European research effort:

The exchange programme involves 32 partners, naturally including leading institutions in large European cities, but we have explicitly aimed to involve also smaller partners in more regional, smaller institutions, to reach out to these regions. We expect this to have a positive effect on the researchers in these institutions as well as to increase their attractiveness for ambitious junior staff and PhD students. We also have a partner institution from Poland, aiding the integration with the Eastern European scientific community.

Making Europe attractive to researchers from the rest of the world.
This exchange programme will first and foremost promote top-quality research in the area of dynamical

systems, and as such re-enforce the leading position of European mathematics in the field of dynamical systems. The leading profile that the European Research Area creates with this project will substantially increase the attractivity of Europe for talented Brazilian researchers and PhD students (who - at leading institutions - are very well educated), but also for leading and talented researchers in other parts of the world.

Increase of mobility of researchers:

There is a good understanding of the open problems and the required method- ology required to approach these. The main obstacle to successful collaboration is the geographical distance between the researchers, and the increased mobility provided by the IRSES will significantly boost the opportunities for joint research, with positive ramifications for the European Research Area. With its specific support for researcher mobility, this partnership will support a large body of top-quality research achievements with a cost-effective investment. On the basis of the quality of the researchers and the strength of the partnership, the proposed exchange programme will open new and important scientific and scholarly horizons.

6.2 Potential to develop lasting collaboration with eligible third country partners, in particular in view of setting-up joint research projects

Dynamical systems research is one of the strengths of Brazilian science, and the main strength of its mathematics programme. With Brazil, and Brazilian science at a crossroads, there are important opportunities for creating lasting collaborations between the ERA and the strongly growing scientific community in Brazil. A systematic programme of exchange visits such as proposed here is ideal to laying the foundations for long-term collaboration, in dynamical systems mathematics, mathematics beyond the field of dynamical systems, and – as a stepping stone – further in the natural sciences and engineering.

In shrill contrast to the financial austerity and reductions of opportunities for most of European (and American) academia, in recent years Brazilian academia is experiencing a rapid expansion. This creates substantial opportunities for the ERA, not in the least because last year the Brazilian government has made internationalisation of its research effort a central priority. One aspect of this is the Science without borders programme that will be sending 70,000 undergraduate and postgraduate students to study at top universities in the world (primarily in Europe and the USA). The main national funding bodies FAPESP (São Paulo state science foundation), CNPq (national science foundation) and CAPES (national foundation for postgraduate education) are increasingly keen to engage in international partnerships and joint international research projects. An illustrative example of this is a recently approved international graduate school on Networks dynamics and applications cofunded by the DFG and FAPESP with €1.5M and €1.2M, respectively, involving universities in São Paulo and Berlin. On another front, Surrey and USP are founding partners, along with North Carolina State University (NCSU), of the Universities Global Partnership Network" (UGPN: http://www.ugpn.org/), launched in October 2011. This is a new approach to university partnerships focusing on deep engagement between a small number of institutions across the world.

There are also increasingly opportunities for international joint research programmes sponsored by international oil companies involved in the exploration of the recently discovered large pre-sal offshore oil fields (as by Brazilian law these firms have to invest part of their turnover in research). To a large extent, European universities are still rather unfamiliar with the Brazilian university system and the opportunities for collaboration it offers. The proposed IRSES will help establish and strengthen relations between European and Brazilian universities on a broad front, helping to remove barriers for cooperation.

More specifically, the need to do diversify mathematics base research while growing the Brazilian higher education sector has created a specific opportunity for collaboration with the Brazilians. While in Europe the job market for academics is likely to be subdued for the near-to-medium term future due to economic stagnation and financial problems in the Euro zone, there is a real risk that large part of a generation of future European researchers will be turned away from academia, creating problems down the line for the sustainability of the European academic sector. At this very moment, with its higher education sector rapidly expanding, Brazil provides a unique opportunity for the best European young researchers to do postdocs and so remain in academia, creating opportunities for a return to Europe when circumstances in the economy and labour market improve. Such arrangements will benefit the Brazilians and Europeans alike and lie a strong basis for increased scientific collaboration in the future.

7 Ethical Issues:

	Research on Human Embryo/Foetus	YES	Page
*	Does the proposed research involve human Embryos		
*	Does the proposed research involve human Foetal Tissues/Cells?		
*	Does the proposed research involve human Embryonic Stem Cells (hESCs)?		
*	Does the proposed research on human Embryonic Stem Cells involve cells in culture?		
*	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	
	Research on Humans	YES	Page
*	Does the proposed research involve children?		
*	Does the proposed research involve patients?		
*	Does the proposed research involve persons not able to give consent?		
*	Does the proposed research involve adult healthy volunteers?		
	Does the proposed research involve Human genetic material?		
	Does the proposed research involve Human biological samples?		
	Does the proposed research involve Human data collection?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	
	Privacy	YES	Page
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?		
	Does the proposed research involve tracking the location or observation of		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	
	Research on Animals	YES	Page
	Does the proposed research involve research on animals?		
	Are those animals transgenic small laboratory animals?		
	Are those animals transgenic farm animals?		
*	Are those animals non-human primates?		
	Are those animals cloned farm animals?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	
	Research Involving Developing Countries	YES	Page
	Does the proposed research involve the use of local resources (genetic, animal, plant, etc)?		
	Is the proposed research of benefit to local communities (e.g. capacity building, access to healthcare, education, etc)?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	
	Dual Use	YES	Page
	Research having direct military use		
	Research having the potential for terrorist abuse		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	X	

Part C

8 Overall Maximum Community Contribution

Table 4. Indicative Budget

A3.1:
Budget

Project Number [1]	318999	Project Acronym [2]	BREUDS

One Form per Project

Participant number in this project	Participant short name	Country	Number seconded researchers month	Total EU Contribution (€)
1	Imperial	United Kingdom	55	115,500.00
2	Warwick	United Kingdom	19	39,900.00
3	Liverpool	United Kingdom	13	27,300.00
4	Surrey	United Kingdom	24	50,400.00
5	QMUL	United Kingdom	10	21,000.00
6	StAndrews	United Kingdom	5	10,500.00
7	VUA	Netherlands	3	6,300.00
8	CNRS	France	55	115,500.00
9	UPEMLV	France	4	8,400.00
10	Augsburg	Germany	7	14,700.00
11	Dresden	Germany	13	27,300.00
12	Pisa	Italy	29	60,900.00
13	UNESCO-ICTP	France	18	37,800.00
14	Porto	Portugal	12	25,200.00
15	UBI	Portugal	4	8,400.00
16	IST	Portugal	12	25,200.00
17	UAB	Spain	15	31,500.00
18	UPC	Spain	19	39,900.00
19	USE	Spain	3	6,300.00
20	IMPAN	Poland	7	14,700.00
21	KTH	Sweden	10	21,000.00
TOTAL (€)			337	707,700.00

Table 5. Indicative Secondments

A3.2:
Indicative Secondments

Project Number [1]	318999	Project Acronym [2]	BREUDS

One Form per Project

Participant number in this project	Participant short name	Country	Amount of staff	Number seconded researchers month total	% Total	EU Contribution (€)
1	Imperial	United Kingdom	26	26	8 %	54,600.00
2	Warwick	United Kingdom	14	14	4 %	29,400.00
3	Liverpool	United Kingdom	4	7	1 %	14,700.00
4	Surrey	United Kingdom	13	13	4 %	27,300.00
5	QMUL	United Kingdom	6	6	2 %	12,600.00
6	StAndrews	United Kingdom	3	3	1 %	6,300.00
7	VUA	Netherlands	3	3	1 %	6,300.00
8	CNRS	France	30	31	9 %	65,100.00
9	UPEMLV	France	3	3	1 %	6,300.00
10	Augsburg	Germany	4	6	1 %	12,600.00
11	Dresden	Germany	7	7	2 %	14,700.00
12	Pisa	Italy	16	17	5 %	35,700.00
13	UNESCO-ICTP	France	7	11	2 %	23,100.00
14	Porto	Portugal	9	9	3 %	18,900.00
15	UBI	Portugal	3	3	1 %	6,300.00
16	IST	Portugal	8	8	2 %	16,800.00
17	UAB	Spain	8	9	2 %	18,900.00
18	UPC	Spain	14	14	4 %	29,400.00
19	USE	Spain	3	3	1 %	6,300.00
20	IMPAN	Poland	3	3	1 %	6,300.00
21	KTH	Sweden	7	7	2 %	14,700.00
22	UFRJ	Brazil	27	27	8 %	56,700.00
23	IMPA	Brazil	12	13	4 %	27,300.00
24	USP	Brazil	32	33	10 %	69,300.00

Participant number in this project	Participant short name	Country	Amount of staff	Number seconded researchers month total	% Total	EU Contribution (€)
25	UFF	Brazil	14	14	4 %	29,400.00
26	UFBA	Brazil	6	6	2 %	12,600.00
27	UNICAMP	Brazil	12	12	4 %	25,200.00
28	UFRGS	Brazil	3	3	1 %	6,300.00
29	UFAL	Brazil	3	3	1 %	6,300.00
30	UNESP	Brazil	7	7	2 %	14,700.00
31	PUC-RIO	Brazil	12	12	4 %	25,200.00
32	UFMG	Brazil	4	4	1 %	8,400.00
TOTAL EU/AC Participant		21	191	203	59 %	426,300.00
TOTAL Third Country Participant		11	132	134	41 %	281,400.00
TOTAL		32	323	337	100 %	707,700.00

9 Grant agreement reporting

REPORT PERIOD	SCIENTIFIC MID-TERM REVIEW REPORT* DUE AT MONTH	PERIODIC REPORTS** DUE AT MONTH	FINAL REPORT DUE AT MONTH
1	12	24	[redacted]
2	36	48	48

* According to Articles III.4 of the Annex III of the grant agreement, the beneficiary shall submit for each reporting period a mid -term interim progress report.
** According to Article 4 of the grant agreement, they include the activity and management reports and the financial statement (Form C).

The Union support of Marie Curie Actions will be referenced in publications, conference papers, presentations and posters in connection with this project. This will include the sentence ”This research was supported by a Marie Curie International Research Staff Exchange Scheme Fellowship within the 7th European Community Framework Programme”, as well as, if relevant, the EU and Marie Curie logos.

ENDPAGE

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International Research Staff Exchange Scheme
Call: FP7-PEOPLE-2012-IRSES

ANNEX 1

"BREUDS"