Dynamics in Samos

31 August - 3 September 2010

Samos, Greece

The aim of this conference is to discuss recent developments in various areas in the field of Differential Equations and Dynamical Systems and their applications in physical sciences and technologies, as well as to provide a forum for recent PhD's and graduate students for interaction with experienced researchers in this field.

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Program with abstracts

Tuesday 31 August 2010

Chair: Nikolaos Alikakos

9:30–10:10

Ricci flow on singular surfaces

Rafe Mazzeo
Stanford University, USA

A number of recent papers have treated Ricci flow on open surfaces. When the initial metric is complete, results are becoming comprehensive. When the initial metric is incomplete, Topping and others have defined a maximal 'instantaneously complete' flow, which is unique in many cases. I will discuss alternate realizations of the Ricci flow for surfaces with conic singularities. There are many possible realizations of the flow which preserve the conic singularities, some which fix the cone angles and some which change them. The main issue is a refined linear regularity theorem for the heat equation on spaces with conic singularities. This is joint work with Rubinstein and Sesum.

Since it is very similar, I will also discuss regularity for another (linear) singular diffusion, known as the Wright-Fisher model in population genetics, which is work in progress with Epstein.

10:15–10:55

Monotone quantities and entropy formulas for geometric evolution equations

Klaus Ecker
Free University Berlin, GERMANY

We discuss various monotone quantities particularly for the Ricci flow and the mean curvature flow. Among those, the entropy monotonicity formula of Perelman will feature prominently which played an important role in the solution of the geometrization conjecture. We will explore avenues for adapting Perelman's

techniques to the mean curvature flow. It turns out, somewhat surprisingly, that there are connections to the differential Harnack inequalities of Hamilton for the mean curvature flow and the one of Li and Yau for the linear heat equation, depending on the entropy one considers.

~: *Coffee Break* :~

Chair: Rafe Mazzeo

11:30–12:10

Minimal surfaces and entire solutions of the Allen-Cahn equation

Michael Kowalczyk
University of Chile, CHILE

We consider the Allen-Cahn equation

$$\Delta u + (1 - u^2)u = 0 \quad \text{in } \mathbb{R}^N. \tag{1}$$

In 1978 E. De Giorgi formulated the following celebrated conjecture:

(DG) *Let u be a bounded solution of equation (1) such that $\partial_{x_N} u > 0$. Then the level sets $[u = \lambda]$ are hyperplanes, at least for dimension $N \leq 8$.*

Equivalently, under the above conditions the statement asserts the existence of $a \in \mathbb{R}^N$, $b \in \mathbb{R}$, $|a| = 1$ such that u has the form

$$u(x) = w(a \cdot x - b)$$

where $w(t)$ is the unique solution of

$$w'' + (1 - w^2)w = 0, \quad w(0) = 0, \quad w(\pm\infty) = \pm 1,$$

namely $w(t) = \tanh(t/\sqrt{2})$. De Giorgi conjecture has been proven in dimensions $N = 2$ by Ghoussoub and Gui and for $N = 3$ by Ambrosio and Cabré. Savin proved its validity for $4 \leq N \leq 8$ under a mild additional assumption. (DG) is a statement parallel to *Bernstein's theorem* for minimal graphs which in its most general form,

due to Simons, states that any minimal hypersurface in $\mathbb{R}^N$, which is also a graph of a function of $N-1$ variables, must be a hyperplane if $N \leq 8$. Bombieri, De Giorgi and Giusti proved that this fact is false in dimension $N \geq 9$, by constructing a nontrivial entire solution to the minimal surface equation

$$\nabla \cdot \left(\frac{\nabla F}{\sqrt{1+|\nabla F|^2}} \right) = 0 \quad \text{in } \mathbb{R}^8,$$

by means of the super-subsolution method. Let us write

$$x' = (x_1, \dots, x_8) \in \mathbb{R}^8, \quad u = \sqrt{x_1^2 + \cdots + x_4^2}, \quad v = \sqrt{x_5^2 + \cdots + x_8^2}.$$

The BDG solution has the form $F(x') = F(u,v)$ with the symmetry property $F(u,v) = -F(v,u)$ if $u \geq v$. In addition we can show that F becomes asymptotic to a function homogeneous of degree 3 that vanishes on the cone $u = v$. Let $\Gamma = \{x_9 = F(x')\}$ be the minimal BDG graph, and let us consider for $\alpha > 0$ its dilation $\Gamma_\alpha = \alpha^{-1}\Gamma$, which is also a minimal graph. Our result, which disproves statement (DG) in dimensions 9 or higher is the following:

Theorem. *Let $N = 9$. For all $\alpha > 0$ sufficiently small there exists a bounded solution $u_\alpha(x)$ of equation ac1 such that*

$$\partial_{x_9} u_\alpha(x) > 0 \quad \textit{for all } x \in \mathbb{R}^9,$$

and such that for $x = y + t\nu(\alpha y)$, where $y \in \Gamma_\alpha$ and ν is a choice of normal to Γ we have

$$u(x) = w(t) + o(1),$$

where $|t| < \frac{\delta}{\alpha}$ and $o(1) \to 0$ uniformly as $\alpha \to 0$.

The method used to prove the above result can be generalized to construct new entire solutions of the Allen-Cahn equation in dimension $N = 3$. We consider a minimal surface M in $\mathbb{R}^3$ which is complete, embedded and has finite total curvature. We assume that M has $m \geq 2$ ends, and additionally that M is non-degenerate, in the sense that its all bounded Jacobi fields can be obtained considering rigid motions of the surface (this is known for instance for a catenoid and for the Costa-Hoffman-Meeks surface of any genus).

We prove that for any small $\alpha > 0$, and up to rigid motions, the Allen-Cahn equation has a family of bounded solutions depending on $m-1$ parameters. Level

sets of these solutions are embedded surfaces lying close to the blown-up surface $M_\alpha := \alpha^{-1}M$, with ends possibly diverging logarithmically from M_α. We prove that these solutions are *L^∞-non-degenerate* up to rigid motions, and find that their Morse index coincides with the index of the minimal surface. Our construction, and known classification results for minimal surfaces, suggest parallels of De Giorgi conjecture for general bounded solutions with finite Morse index.

Joint work with M. del Pino and J. Wei

12:15–12:55

An analytic approach to the normalized Ricci flow-like equation

Nikos Kavallaris
University of the Aegean, GREECE

We study a parabolic equation with a non-local term defined on a compact two-dimensional Riemannian surface Ω. When the total mass of the solution, which is the actual parameter of the problem, is equal to 8π and the surface Ω is the standard sphere S^2, then the equation describes the Hamilton's normalized Ricci flow. We obtain, using classical arguments of the parabolic PDE theory, the global in time existence of the solution to this problem for $0 < \lambda \leqslant 8\pi$. Morever, it is proved that if $0 < \lambda < 8\pi$ the orbit is compact, while for $\lambda = 8\pi$ there is a time sequence along which the solution converges to a stationary solution.

Joint work with T. Suzuki

13:00–13:20

Symmetries and Noether Integrals

Peter Leach
University of the Aegean, GREECE

The value of the Last Multiplier of Jacobi was enhanced by the connection with symmetries developed by Lie. Since the existence of a multiplier provides a route to the determination of a Lagrangian, an equation with a suitable number of Lie symmetries can have a Lagrangian which is obtained by quadratures. We demonstrate this in detail for systems of one degree of freedom and show how to deal with systems of more than one degree of freedom.

~: *Lunch Break* :~

Chair: Vassilis Papanicolaou

17:30–18:10

Single-point gradient blow-up on the boundary for diffusive Hamilton-Jacobi equations in planar domains

Philippe Souplet
Université de Paris XIII "Paris-Nord", FRANCE

Consider the diffusive Hamilton-Jacobi equation $u_t = u + |\nabla u|^p$, $p > 2$, on a bounded domain with zero-Dirichlet boundary conditions, which arises in the KPZ model of growing interfaces. It is known that u remains bounded and that ∇u may blow up only on the boundary $\partial\Omega$. Under suitable assumptions on the domain $\Omega \subset \mathbb{R}^2$ and on the initial data, we show that the gradient blow-up singularity occurs only at a single point $x_0 \in \partial\Omega$. This is the first result of this kind in the study of problems involving gradient blow-up phenomena. In general domains of $\mathbb{R}^n$, we also obtain results on nondegeneracy and localization of blow-up points.

Joint work with Yuxiang Li

18:15–18:55

Stochastic saddle paths and economic dynamics

Athanasios N. Yannacopoulos
The Athens University of Economics and Business Science, GREECE

We present a generalization of saddle paths for stochastic systems, using the theory of backward stochastic differential equations and discuss its applicability to economic dynamics. Applications in macroeconomic theory and economic policy are discussed.

Wednesday 1 September 2010

9:00–9:20 Ceremony for the International Award "Stephanos Pnevmatikos". Presentation of the recipient: *George Tsironis*, Department of Physics, University of Crete and Institute of Electronic Structure and Laser, FORTH.

Chair: Dimitris Frantzeskakis

9:30–10:10

Dark Solitons and Vortices in Bose-Einstein Condensates: Oscillations and Precessions, Dynamics and Interactions in an Ultracold World

Panayotis Kevrekidis
University of Massachussetts, USA

In this talk, we will present an overview of recent theoretical, numerical and experimental work concerning the static, stability, bifurcation and dynamic properties of coherent structures that can emerge in one- and higher-dimensional settings within Bose-Einstein condensates at the coldest temperatures in the universe (i.e., at the nanoKelvin scale). We will discuss how this ultracold quantum mechanical setting can be approximated at a mean-field level by a deterministic PDE of the nonlinear Schrodinger type and what the fundamental nonlinear waves of the latter are. Then, we will try to go to a further layer of simplified description via nonlinear ODEs encompassing the dynamics of the waves within the traps that confine them, and the interactions between them. Finally, we will attempt to compare the analytical and numerical implementation of these reduced descriptions to recent experimental results and speculate towards a number of interesting future directions within this field.

10:15–10:55

On the study of a generalized Cahn-Hilliard equation with forcing and stochastic terms

Georgia Karali
University of Crete, GREECE

We consider the Cahn-Hilliard equation on a bounded domain and introduce forcing terms of general type. We derive asymptotic results, the sharp interface limit in the multidimensional case and a linear diffusion equation in the one-dimensional case with noise-like non homogeneous term by making use of the Brownian scale. We also discuss about front motion in the one-dimensional stochastic Cahn-Hilliard equation and existence for a generalized stochastic one posed on bounded convex domains.

~: *Coffee Break* :~

Chair: Mihalis Anoussis

11:30–12:10

On the existence of entire solutions to variational elliptic systems under reflection symmetries

Giorgio Fusco
Universita' degli Studi dell' Acquila, ITALY

We show that the technique developed in [AF] can he adapted to a general context where more complex kinds of symmetries are allowed. This leads to an abstract theorem which extend the results in [AF] and includes as special cases various other situations studied in the literature. We consider finite reflection groups G and G' acting on $\mathbb{R}^m$, $m \geq 1$ and $\mathbb{R}^n$, $n \geq 1$ respectively and a homomorphism

$\rho : G \to G'$ and define a map $u : B_L \subset \mathbb{R}^m \to \mathbb{R}^n$, $B_L = \{x \in \mathbb{R}^n : |x| < L\}$, $L \in (0, +\infty]$ to be equivariant with respect to the action of G and G' if

$$\rho(g)u(x) = u(gx), \quad \forall x \in B_L,\ g \in G.$$

We study the existence of equivariant entire solutions $u : \mathbb{R}^m \to \mathbb{R}^n$ of the elliptic system

$$\Delta u = W_u(u), \quad x \in \mathbb{R}^m,$$

Where $W : \mathbb{R}^n \to \mathbb{R}$ is a C^2 potential.

[AF] N.D. Alikakos, G. Fusco Entire solutions to cqfaifuariaiit elliptic systems with variational structure.

Joint with N.D. Alikakos

12:15–12:55

Stationary and Traveling Waves in Lattices with saturable nonlinearities

Vassilis Rothos
Aristotle University of Thessaloniki, GREECE

We demonstrate existence of discrete solitons in Discrete Nonlinear Schrodinger equation (DLNS) with saturable nonlinearity. We consider two types of solutions to DLNS periodic and vanishing at infinity. In the second part of our talk, we prove the existence of periodic and solitary traveling waves in Fermi-Pasta-Ulam lattices with saturable nonlinearities. Calculus of variations and Nehari manifolds are employed to establish the existence of these solutions. We present some extensions of our results, combining the Nehari manifold approach and the Mountain Pass argument.

Joint work with Alex Pankov

13:00–13:20

Existence and stability of phase-shift multibreathers in Klein-Gordon chains with long range interactions

Vassilis Koukouloyannis
Technological Education Institution of Serres, GREECE

A classical 1D Klein-Gordon chain with nearest-neighbor interaction cannot support phase-shift discrete breathers i.e. breathers with phase difference between

successive central oscillators different from 0 or π. The situation changes when long-range interactions are introduced. Phase-shift breathers also appear in 2D Klein-Gordon lattices in the form of vortex breathers. In the 2D case the existence of long-range interactions can critically effect the stability of some of these structures. A comparison with the corresponding results in the DNLS is performed.

~: *Lunch Break* :~

Chair: Klaus Ecker

17:30–18:10

The dynamics of waves on black hole backgrounds in general relativity

Mihalis Dafermos
University of Cambridge, UK

18:15–18:55

Geometric flows and instantons at a Lifshitz point

Ioannis Bakas
University of Patras, GREECE

I provide a broad framework to embed flow equations in non-relativistic field theory models that exhibit anisotropic scaling. The prime example is the heat equation arising from a Lifshitz scalar field. Then, I review recent results reported in arXiv:1002.0062 describing instanton solutions of Horava-Lifshitz gravity as eternal solutions of certain geometric flow equations on 3-manifolds. Some general connections with the Onsager-Machlup theory of non-equilibrium processes are also discussed in this context.

~: *Coffee Break* :~

19:00–19:20

Center manifold theory in cosmological dynamical systems

Ioannis Miritzis
Universaity of the Aegean, GREECE

For a dynamical system whose equilibria are non-hyperbolic, the linearization theorem does not yield any information about their stability. We outline the center manifold theory and illustrate the method by a cosmological dynamical system.

Thursday 2 September 2010

The Morning Session is dedicated to the retirement of Professor Chris Eilbeck

Chair: Achilles Tertikas

9:30–10:10

Breathers and kinks in a simulated crystal experiment

Chris Eilbeck
Heriot-Watt University, UK

Much has been written about the theoretical possibilities of localized waves in solid state situations, but very little has been done to investigate the experimental side. However recent experiments by Mike Russell (EPL 78, 10004, 2007) have, for the first time, provided strong support for the existence of long-lived *mobile* local vibrational modes in a real layered crystal. I will survey the ideas behind these concepts and report on the first attempts to simulate the experiment with a toy 1D model. The model includes particles colliding with and ejected from the crystal surface.

Joint work with Q. Dou, J. Cuevas and F.M. Russell

10:15–10:55

Matter-wave dark solitons: analytical results and connection to experiments

Dimitrios Frantzeskakis
University of Athens, GREECE

We study dark solitons (DSs) in Bose-Einstein condensates (BECs). First, we present the mean-field model, i.e., the three-dimensional (3D) Gross-Pitaevskii equation (GPE), its reduction to a one-dimensional (1D) equation and its DS solutions. Next, we consider the dynamics of DSs in quasi-1D BECs in a trap. We use a Hamiltonian perturbation theory to describe the the DS dynamics and the soliton equation of

motion. Then, we present the effect of BEC dimensionality on the stability, as well as the static and dynamic properties of DS. We compare the analytical results with recent experimental ones, demonstrating oscillations and interactions of DSs in BECs. We finally discuss finite-temperature effects on the statics and dynamics of DSs in BECs. Particularly, we use a dissipative GPE (DGPE), which is analytically treated by means of the Hamiltonian perturbation theory. Results obtained in the framework of the DGPE are found to be in good agreement with ones obtained by means of the stochastic GPE.

~: *Coffee Break* :~

Chair: Dimitrios Tzanetis

11:30–12:10

Combinatorics of KP line solitons

Aristophanes Dimakis
University of the Aegean, GREECE

The KP-II equation possesses a class of line soliton solutions which can be qualitatively described as a sequence of binary trees, except at critical times where a transition to a different binary tree takes place. We prove that these sequences correspond to maximal paths in a Tamari lattice. This yields a description of possible evolutions of line soliton patterns on a shallow fluid surface, provided that the KP-II approximation applies.

12:15–12:55

Effective dynamics in macroscopically modulated waves in nonlinear lattices

Ioannis Giannoulis
Technische Universität München, GERMANY

We consider nonlinear lattices in one or several space dimensions. Taking an arbitrary plane-wave solution of the linearized model, we modulate its (constant) amplitude macroscopically in space in time, that is to say – in the case of space – at a

scale much larger than the distance of the atoms when in rest. We want to obtain and justify analytically an equation desribing the dynamics of this macroscopic amplitude directly, i.e., as a function of the macroscopic space and time variables (effective dynamics). We explain this approach on hand of examples, depending on the physical phenomena one is interested in. The talk will have an introductory character, aiming at an audience who is not familiar with this method.

13:00–13:20

A perturbative approach to the Lifshitz-Slyozov-Wagner theory

Apostolos Damialis
University of Athens, GREECE

In this talk we present a perturbative framework that extends the classical Lifshitz–Slyozov–Wagner theory for Ostwald ripening (i.e., for a dilute system of particles that coarsens through diffusional interactions). In order to capture the effect of spatial correlations between particles beyond the mean-field approximation, we consider Hilbert-like expansions that result in a closed hierarchy of conservation laws for appropriate correlation distribution functions. We will discuss the role of self-similarity in this context and also how related extended theories, like the one proposed by Marqusee and Ross, fit into our approach.

~: *Lunch Break* :~

Chair: Phillipe Souplet

17:30–18:10

Dynamics of Vertical Fire Spread

Andrew Lacey
Heriot-Watt University, UK

A model for the propagation of a flame up a vertical, combustible wall is presented. The model is based on the assumption of a uniform heat flux from the flame into the wall. The size of the flame and the heat flux are determined by the rate of release of flammable gases through pyrolysis within the wall. Some analytical and numerical solutions are obtained.

18:15–18:55

The Spherically Symmetric Inverse Transmission Eigenvalue Problem

Vassilis Papanicolaou
National Technical University of Athens, GREECE

We consider the transmission eigenvalue problem for a spherically symmetric index of refraction $\sqrt{\rho}$, where $\rho > 0$. We show that if ρ satisfies some integral bound, then it can be recovered from the transmission eigenvalues for which the corresponding eigenfunctions are spherically symmetric. We also consider the associated problem for the Schrödinger operator.

Joint work with T. Aktosun and D. Gintides

~: *Coffee Break* :~

19:00–19:20

Blow-up of solutions for a semi-linear filtration problem

Evangelos Latos
National Technical University of Athens, GREECE

We investigate the behaviour of solutions for an initial (positive initial data) and boundary value problem for the Filtration equation $u_t = \Delta K(u) + \lambda f(u)$, $x \in \Omega \subset \mathbb{R}^N$. The functions $f(s)$ and $K(s)$ are positive, increasing, convex and $K'(s)/f(s)$, is integrable at infinity ($f(s)$ and $K(s)$ behave like e^s or like $(1+s)^p$, $p > 1$). We prove that there exists a critical value λ^* such that for $0 < \lambda \leq \lambda^*$ there exists at least a steady-state solution, while for $\lambda > \lambda^*$ there is no steady-state solution and the solution $u(x,t)$ blows up in finite time.

Joint work with D. Tzanetis

~: *21:00 Conference Dinner* :~

Friday 3 September 2010

Chair: Michael Kowalczyk

9:30–10:10

A Hyperbolic Non-Local Problem Modelling MEMS Technology

Dimitrios Tzanetis
National Technical University of Athens, GREECE

In this work we study a non-local hyperbolic problem of the form $u_{tt} = u_{xx} + \lambda/(1-u)^2 \left(1 + \alpha \int_0^1 \frac{1}{1-u} dx\right)^2$, with homogeneous Dirichlet boundary conditions and appropriate initial conditions. This problem models an idealised electrostatically actuated MEMS (Micro-Electro-Mechanical System) device. Initially we present the derivation of the model. Then we prove local existence of solutions for $\lambda > 0$ and global existence for $0 < \lambda < \lambda_-^*$, for zero initial conditions; similar results are obtained for other initial conditions. For larger values of the parameter λ, *i.e.* when $\lambda > \lambda_+^*$ for some constant $\lambda_+^* > \lambda_-^*$, and for zero initial conditions, it is proved that the solution of the problem quenches in finite time. In addition for the case that the initial deformation and velocity are non-zero it is also proved that the solution quenches if λ is large enough. Finally the problem is solved numerically with a finite difference scheme. Various simulations of the solution of the problem are presented, illustrating the relevant theoretical results.

Joint work with N.I. Kavallaris, A.A. Lacey and C.V. Nikolopoulos

10:15–10:55

Finite Element Approximations for a linear stochastic Cahn-Hilliard equation

Georgios Zouraris
University of Crete, GREECE

We consider an initial and Dirichlet boundary value problem for a linear stochastic Cahn-Hilliard equation, forced by an additive space-time white noise or by the space derivative of a space-time white noise. We construct fully-discrete finite

element approximations to the solution of the problem and analyze their convergence by proving strong error estimates.

~: *Coffee Break* :~

Chair: Evaggelos Stefanopoulos

11:30–11:50

Heteroclinic orbits in slow-fast Hamiltonian systems with slow manifold bifurcations

Christos Sourdis

Motivated by a problem in which a heteroclinic orbit represents a moving interface between ordered and disordered crystalline states, we consider a class of slow-fast Hamiltonian systems in which the slow manifold loses normal hyperbolicity due to a transcritical or pitchfork bifurcation as a slow variable changes. We show that under assumptions appropriate to the motivating problem, a singular heteroclinic solution gives rise to a true heteroclinic solution. In contrast to previous approaches to such problems, our approach uses blow-up of the bifurcation manifold, which allows geometric matching of inner and outer solutions.

Joint work with Stephen Schecter

11:55–12:20

On the numerical solution of nonlinear integral equations in elastodynamics

Leonidas Mindrinos
National Technical University of Athens, GREECE

We consider the inverse scattering problem of determining the shape of an inclusion in a homogeneous and isotropic two dimensional elastic medium. This

problem is solved using the method of nonlinear integral equations based on the integral representation of the scattered field. Since the operators are nonlinear we used Fréchet derivatives with respect to the parameterization of the boundary. The weakly and strongly singular integral operators are computed using special collocation and quadrature rules. In view of the ill-posedness, the linearized system is solved via Tikhonov regularization. The numerical solution is achieved via an iterative algorithm based on an initial guess about the boundary. Reconstructions are given which illustrate the applicability of the method.

Joint work with D. Gintides

List of Participants

Achilleos Vassos, University of Athens, GREECE
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Anoussis Mihalis, University of the Aegean, GREECE
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Famous men and women of ancient Samos

There is a big number of famous Samian men and women of antiquity. Among them there are many Mathematicians of both genders.

Pythagóras (ΠΥΘΑΓΟΡΑΣ) is widely known from the Pythagorean theorem, the fact that there are irrational numbers, and his work on musical scales. The name Pythagoras is common on Samos and still in use. We will not say more about him and his schools but we will present some of his women students who are much less known although very important. **Theanó** (ΘΕΑΝΩ) was Pythagoras wife. She was not from Samos but she lived here and was the director of Pythagoras school after his death. Very famous mathematicians were Pythagoras' daughters: **Damó** (ΔΑΜΩ), **Myría** (ΜΥΡΙΑ) and **Arignótee** (ΑΡΙΓΝΩΤΗ).

Damo taught mathematics in Croton in south Italy, and after her father's death she published the "geometric courses" (ΓΕΩΜΕΤΡΙΚΗ ΔΙΔΑΣΚΑΛΙΑ). She believed that "among all solids the most 'beautiful' is the sphere and among all planar curves the circle".

Myria also taught in the school of Croton and we know that she is the person to invent the idea of the "third median" (ΤΡΙΤΗ ΜΕΣΟΤΗΣ).

Arignotee was very much respected for her teaching and contribution to Mathematics and many philosophers and lexicographers have references to her.

Deinó (ΔΕΙΝΩ) was very strong mathematician; student and mother in law of Pythagoras! She studied extensively the elliptic numbers (ΕΛΛΙΠΤΙΚΟΙ ΑΡΙΘΜΟΙ). (these are the numbers whose smaller divisors add up to a sum smaller than themselves; for example, 8 is elliptic since $8 > 4 + 2 + 1$).

Melíssa (ΜΕΛΙΣΣΑ) was a student of Pythagoras. She published at least one work, which has been lost, about the relations of the circle with the set of all inscribed polygons ("Ο ΚΥΚΛΟΣ ΤΩΝ ΕΓΓΕΓΡΑΜΕΝΩΝ ΠΟΛΥΓΩΝΩΝ ΑΠΑΝΤΩΝ ΕΣΤΙ").

Vitálee (ΒΙΤΑΛΗ) was the daughter of Damo, that is, the granddaughter of Pythagoras. When Damo died she left to her all the work of her father Pythagoras with the order never to publish them. Although she suffered from extreme poverty she systematically refused to publish the mathematical and philosophical work of

her grandfather. Only very close to her death she was convinced to publish the "Golden Epics" (ΧΡΥΣΑ ΕΠΗ), thirty sentences of Pythagoras.

Other than Mathematicians, Samos had famous people in several other disciplines.

Arístarchos (ΑΡΙΣΤΑΡΧΟΣ) was the first to support the idea that the Sun is at the center of our solar system. He supported the idea that the Sun does not move but it is the Earth that moves around the Sun.

Although **Cónon** (ΚΟΝΩΝ) was a famous astronomer his name has been widely known by the fact that he was a close friend of Archimedes. The latter was writing to him his mathematical inventions. Mainly from these letters is that we know the work of Archimedes today.

Epíkouros (ΕΠΙΚΟΥΡΟΣ) was born, grown up, and studied philosophy on Samos. His parents were Athenians. Much later in his life he moved to Athens were he founded his school known as "the garden". In the core of his philosophy was the meaning of "pleasure" (ΗΔΟΝΗ). A well know phrase of him was "if you guarantee me that I will always have bread and water I will compete with Zeus as to who is the happier".

Ríkos (ΡΟΙΚΟΣ) and **Theódoros** (ΘΕΟΔΩΡΟΣ) father and son were the founders of the famous Samian school of sculpture and among the most distinguished sculptors of the ancient world. They were the architects of the temple of Hera on Samos (the second time it was built), discovered several new techniques in sculpture, and were the first who created keys. They also built the temple of Artemis in Ephesus. Theodoros had a son named **Tileklís** (ΤΗΛΕΚΛΗΣ), a famous sculptor as well, who in his turn had a son, again named **Theódoros** (ΘΕΟΔΩΡΟΣ) who was consider a genius in sculpture, during the era of Polykratis.

Geneleós (ΓΕΝΕΛΕΩΣ) was one of the most deeply respected sculptor of the Samian school. One of his masterpieces, a complex of six statues is partly saved today and can be seen in the Museum in Samos city (Vathý). A copy of this has been placed in the archaeological site of the Hera's temple. Works of him exist in many museums around the world such as in Berlin and Paris (in Louvre).

Mandroklís (ΜΑΝΔΡΟΚΛΗΣ) was the first to build a bridge at the sea of Marmara (joining Europe and Asia Minor) of length 2300 meters for the Persian troops when they moved against the Scythians.

Erasistratos (ΕΡΑΣΙΣΤΡΑΤΟΣ, around 300 BCE) was a distinguished medical doctor. His theories were in use many centuries after his death and the Emperor Julian writes enthusiastically about him in his Antiochikos speech.

The wine of Samos

The vineyard of Samos is one of the best known internationally. The dominant variety is called “muscat blanc”. Since the microclima of Samos has been proven to be optimal for this grape it is also widely known as “Muscat of Samos”. The production is more than 8000 tons of must per year and more than half of it is exported (after vinification) to enhance the flavor of the highest quality of champagne. The wine is vinified by the local Union of Vinicultural Cooperatives of Samos producing high quality sweet wine and dry white wine.

If you would like to try dry wine the best is “Ageri” (Αγέρι, sea breeze), and “Psiles Korfes” (Ψηλές Κορφές, high mountain peaks) (around 8 euros).

But it is the sweet wine that brings Samos to the top quality producers worldwide. Among the sweet wines the best is “Anthemis” (Ανθεμίς is an ancient name of Samos), and it is prized around 10 euros. This wine is aged in small French oak barrels for five years.

“Nectar” (Νέκταρ) is the most expensive wine of Samos (around 12 euros) but not necessarily better than Anthemis. It is more expensive because the grapes are set to dry to a certain point under the sun, decreasing their juices and thus increasing the grapes per bottle rate.

Very good quality for everyday drinking is the simplest of all, called just “Vin Doux”. All cafés and restaurants on Samos will serve you this if asked for sweet wine.

Finally the “Grand Cru” is made of high quality mountain grapes and it is less sweet than the others. This wine is the one massively exported to France and other countries. It has a very fresh taste and it is more acidic, making it ideal for consumption during the warm summer months.

Two organic wines are also produced. “Dryousa”, a dry wine (Δρυούσα is another name of ancient Samos), and “Fyllas” a sweet wine (Φυλλάς is yet another name of ancient Samos).

All prices given above are estimated prices of wine stores. In restaurants the prices are much higher.

Practical Information

Sites related to antiquity

Hera's Temple one of the most important sanctuaries of ancient Greece is located seven kilometres southwest of Pythagorion. The sanctuary was an integral part of the ancient city of Samos, with which it was linked politically and administratively and to which the Sacred Way led.

The sanctuary was built at the mouth of the Imbrasus river on terrain which is not especially stable, but it seems that this was dictated by the fact that this particular spot was associated with the worship of the goddess Hera.

The first evidence of such a cult can be traced back to the second half of the 2nd millennium BCE. The altar was small but in the 7th century BCE it was rebuild and took on monumental form.

Rhoecus and Theodorus supervised the erection of the great temple to Hera in the early 6th century BCE. This had monumental proportions (52.5×105.8 meters).

From the 155 columns, whose height was 20 meters, only a part of one of them survived.

The site can be visited Tuesday to Sunday (Monday is closed) from 8:30 to 15:00. Entrance fee is 3 euros (people above 62 years: 2 euros, children: no fee).

Archaeological Museum at the city of Samos (Vathý). Forty minutes drive from Karlovassi, the Museum is built next to the City Hall. It has important findings from the Temple of Hera including the impressive 4.75 meter Kouros (580 BCE). The site is open Tuesday to Sunday (Monday is closed) from 8:30 to 15:00. Entrance fee is 3 euros (people above 62 years: 2 euros, children: no fee).

Eupalinion tunnel was built by the famous engineer Eupalinos of the city Megara during the era of Polykratis and Pythagoras. It is a 1032 meters tunnel that was created in order to bring water to the ancient city of today's Pythagorion from the north side. Two groups started to dig from opposite sides and they

met in the center of the mountain with an error of less than 1 meter, a quite impressive accomplishment for that time. At this moment only the first 150 meters can be visited. The tunnel can be visited from Tuesday to Sunday (Monday is closed) from 8:30 to 15:00. Entrance fee is 3 euros (people above 62 years: 2 euros, children: no fee).

Touristic sites (other than Pythagorion)

Kokkari is a very beautiful and very touristic (but still quiet) village at the north part of Samos. It is half an hour drive from Karlovassi.

Manolates is a traditional village high in the central mountain called Ampelos (that is, vine). It is about twenty minutes drive from Karlovassi and it is worth the trouble to visit it. The village is located above a dense forest, and has an excellent view. Be careful: the road to the village is very steep.

Useful telephone numbers

Taxi service at Karlovassi: 22730-30777

Hospital at Samos city (Vathý): 22730-83100

Port Authorities at Karlovassi: 22730-30888

Port Authorities in Samos city (Vathý): 22730-27318

Port Authorities at Piraeus: 210-4511-31X, where $X = 0, 1, \ldots, 7$.

Airport: 22730-61219

Olympic Airways: 22730-23927

Aegean Airways: 22730-62790

Police Station at Karlovassi: 22730-32444

Police Station at Samos city (Vathý): 22730-27980

Touristic Police of Samos: 22730-27404

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