

Colloquium Final Report Form

Title: **Biomechanics of the Eye**

Colloquium No: **533**

Dates and location: **22nd-24th of July 2013, Genoa, Italy**

Chairperson: **Rodolfo Repetto**

Co-Chairperson: **Jennifer H. Siggers**

Michael Girard (National University of Singapore, Singapore) and Alessandro Stocchino (University of Genoa, Italy) were also part of the organising committee.

Is there need of another Colloquium on the same or a related subject? Which year?

A first Euromech Colloquium on this topic (518) was organised in London, in the year 2010. In the organising committee's view this second Colloquium was very effective and successful. Therefore, we think that another future Colloquium on the biomechanics of the eye could be equally useful. We suggest this could be organised in the year 2016.

Full registration fee:

Non-student fee: 400 € + 24 €

Student fee: 250 € + 24 €

What other funding was obtained? **1000 € from the University of Genoa**

What were the participants offered?

- **5 coffee breaks;**
- **3 lunches;**
- **1 dinner;**
- **a guided tour of Genoa;**
- **a folder containing:**
 - **programme of the colloquium,**
 - **book of abstracts,**
 - **list of participants,**
 - **a block and pen,**
 - **instructions for internet connection,**
 - **touristic material,**
 - **Euromech brochure.**

Number of members of Euromech (reduced registration fee) **0**

Number of non-members of Euromech (full registration fee) **35**

Number of participants from each country:

Austria		United Kingdom	5	Slovakia	
Belgium		Greece		Slovenia	
Bosnia		Hungary	1	Spain	

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Byelorussia		Ireland		Sweden	
Bulgaria		Italy	15	Switzerland	2
Croatia		Latvia		Ukraine	
Czech Republic		Lithuania		Serbia	
Denmark		Netherlands		Montenegro	
Estonia		Norway		Turkey	1
Finland		Poland	3	Others	6
France		Portugal			
Georgia		Romania			
Germany	1	Russia	1	Total	35

List names of Applicants to EUROMECH:

- 1. Angelillo Maurizio**
- 2. Bocksai Zoltan**
- 3. Bonfiglio Andrea**
- 4. Bottega William**
- 5. Braakman Sietse**
- 6. Braun Richard**
- 7. Buchler Philippe**
- 8. Burgoyne Claude**
- 9. Causin Paola**
- 10. Clemente Chiara**
- 11. Colombini Marco Enrico**
- 12. Fitt Alistair**
- 13. Giannetti Flavio**
- 14. Girard Michael**
- 15. Isakova Krystyna**
- 16. Kasprzak Enryk**
- 17. Kimpton Laura**
- 18. Luthert Philip**
- 19. Meskauskas julia**
- 20. Pandolfi Anna**
- 21. Pinsky Peter**
- 22. Pokki Juho**
- 23. Pralits Jan**
- 24. Repetto Rodolfo**
- 25. Romano Mario**
- 26. Sacco Riccardo**
- 27. Sevom Sevih**
- 28. Siggers Jennifer H.**
- 29. Simonini Irene**
- 30. Stocchino Alessandro**
- 31. Szmigiel Marta**
- 32. Vasta Marcello**
- 33. Wang Zhongkui**
- 34. Widlicka Magdalena**
- 35. Yakushev Vladimir**

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Colloquium No 533 Scientific Report

Mechanics plays an extremely important role in the functioning of the eye, in both health and disease. The themes of this colloquium included any application of mechanics to physiology or pathological conditions affecting the eye. For example in the Colloquium the following subjects were treated: the physiology the cornea, lens, sclera, aqueous humour, vitreous humour, lamina cribrosa, optic nerve, tear film, retinal blood circulation, the effect of pathological conditions such as keratoconus, glaucoma and retinal detachment.

There were 35 official participants, from 11 different countries, plus several locals, from the University of Genoa, who attended some of the talks. Participants had different backgrounds (ophthalmology, engineering, physics, mathematics), thus the environment was highly multidisciplinary. This is essential when dealing with a the multidisciplinary topic such as the one of this Colloquium. We had four 60-minute long presentations by the following distinguished invited speakers:

- Peter Pinsky, Department of Mechanical Engineering, Stanford University, USA.
- Claude F. Burgoyne, Optic Nerve Head Research Laboratory, Devers Eye Institute, USA.
- Phil Luthert, Institute of Ophthalmology, University College London, UK.
- Richard J. Braun, Department of Mathematical Sciences, University of Delaware, USA.

We were able to provide financial support for the invited speakers to attend the colloquium. In addition we had 25 contributed talks. Details of the Colloquium programme are given below:

Monday 22nd

Presentations	
9:00	Registration
9:20	
9:40	Opening
10:00	Invited presentation
10:20	P. Pinsky (Department of Mechanical Engineering, Stanford University, USA)
10:40	<i>Structural models of the human cornea - from molecular to macroscopic scales</i> Chair: P. Büchler (Institute for Surgical Technology & Biomechanics, University of Bern, Switzerland)
11:00	Coffee break
11:20	
Session: Biomechanics of the cornea I	
Chair: M. Vasta (Dipartimento di Ingegneria e Geologia, University of Chieti-Pescara, Italy)	
11:40	M. Angelillo (Dipartimento di Ingegneria Civile, University of Salerno, Italy) <i>The response of ocular analyzers as a problem of non-linear dynamics</i>
12:00	P. Büchler (Institute for Surgical Technology & Biomechanics, University of Bern, Switzerland)

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	<i>Clinical validation of a patient-specific model of the cornea on cararact interventions</i>
12:20	A. Pandolfi (Department of Civil and Environmental Engineering, Politecnico di Milano, Italy) <i>Numerical simulations of corneal refractive surgery</i>
12:40	M. Asejczyk-Widlicka (Institute of Physics, Wrocław University of Technology, Poland) <i>Applanation pressure function in Goldmann tonometry and its correction</i>
13:00	Lunch
13:20	
13:40	
14:00	
Session: Dynamics of the vitreous humour	
Chair: R. Sacco (Department of Mathematics, Politecnico di Milano, Italy)	
14:20	M. Colombini (Department of Civil, Chemical and Environmental Engineering, University of Genoa, Italy) <i>Numerical simulation of the motion of a viscous fluid in a rotating sphere</i>
14:40	Julia Meskauskas (University of Goettingen, Germany) <i>A mathematical model of the steady streaming flow in the vitreous chamber</i>
15:00	A. Bonfiglio (Department of Civil, Chemical and Environmental Engineering, University of Genoa, Italy) <i>In-vitro experimental study of the motion of the vitreous humour induced by eye rotations</i>
Session: Biomechanics of the retina and eye injury	
Chair: J. H. Siggers (Imperial College London, UK)	
15:20	W. J. Bottega (Department of Mechanical & Aerospace Engineering, Rutgers University, Piscataway, USA) <i>The effect of meridian displacement on the behaviour of a detaching retina</i>
15:40	R. Sacco (Department of Mathematics, Politecnico di Milano, Italy) <i>Multiscale models of retinal microcirculation: blood flow and mass transport phenomena 1</i>
16:00	Coffee break
16:20	P. Causin (Department of Mathematics, University of Milano, Italy) <i>Multiscale models of retinal microcirculation: blood flow and mass transport phenomena 2</i>
16:40	C. Clemente (Department of Civil and Mechanical Engineering, University of Cassino, Italy) <i>The biomechanics of the eye under high speed impact</i>

Tuesday 23rd

Presentations	
9:40	Invited presentation:

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10:00	C. Burgoyne (Optic Nerve Head Research Laboratory, Legacy Research Institute and Devers Eye Institute, portland, USA)
10:20	<i>20 years from onset through endstage in the monkey experimental glaucoma model – what we have learned and what I most want to know next</i> Chair: M. Angelillo (Dipartimento di Ingegneria Civile, University of Salerno, Italy)
Session: Biomechanics of glaucoma Chair: A. Stocchino (University of Genoa, Italy)	
10:40	S.T. Braakman (Department of Bioengineering, Imperial College London, UK) <i>Transport across Schlemm's canal endothelium</i>
11:00	Coffee break
11:20	M. Girard (National University of Singapore, Singapore) <i>Methods for characterising optic nerve head biomechanics in vivo</i>
11:40	J. H. Siggers (Department of Bioengineering, Imperial College London, UK) <i>Flow of aqueous humour in the posterior chamber of the eye: implications for the development of glaucoma</i>
12:00	A. D. Fitt (Oxford Brookes University, UK) <i>Aqueous outflow in the deformable trabecular meshwork and the Schlemm canal</i>
Session: Zonular fibres and iris Chair: Mario Romano (Department of Ophthalmology, Istituto Clinico Humanitas, Milan, Italy)	
12:20	Z. Bocskai (Department of Structural Mechanics, Budapest University of Technology and Economics, Hungary) <i>Measurement of porcine zonular fibres</i>
12:40	M. Szmigiel (Institute of Physics, Wroclaw University of Technology, Poland) <i>Investigation of the dependency between dynamics of the pupil geometry and blood pulsation</i>
13:00	Lunch
13:20	
13:40	
14:00	
14:20	Invited presentation
14:40	P. Luthert (Institute of Ophthalmology, University College London, UK) <i>What modeling can bring to understanding of pathogenesis and therapeutics in eye disease</i> Chair: A. Fitt (Oxford Brookes University, UK)
15:00	
Session: Dynamics of the vitreous humour and vitreous mechanical properties Chair: W. J. Bottega (Department of Mechanical & Aerospace Engineering, Rutgers University, Piscataway, USA)	

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15:20	A. Stocchino (Department of Civil, Chemical and Environmental Engineering, University of Genoa, Italy) <i>In-vivo measurement of the motion of the vitreous humour induced by eye rotations</i>
15:40	Coffee break
16:00	Z. Wang (Department of Robotics, Ritsumeikan University, Japan) <i>Study of biomechanical properties of vitreous humor by a finite element model</i>
16:20	J. Pokki (Institute of Robotics and Intelligent Systems, ETH Zurich, Switzerland) <i>Vitreous humor viscoelasticity measured by intraocular microprobes</i>
20:00	Conference Dinner

Wednesday 24th

Presentations	
9:40	Invited presentation:
10:00	R. J. Braun (Department of Mathematical Sciences, University of Delaware, USA) <i>Models for Tear Film Dynamics</i>
10:20	Chair: H. Kasprzak (Institute of Physics, Wrocław University of Technology, Poland)
Session: Biomechanics of the cornea II Chair: M. Girard (National University of Singapore, Singapore)	
10:40	M. Vasta (Dipartimento di Ingegneria e Geologia, University of Chieti-Pescara, Italy) <i>A comparison between two and three dimensional fiber distributed models for the mechanical characterisation of the human cornea</i>
11:00	Coffee break
11:20	H. Kasprzak (Institute of Physics, Wrocław University of Technology, Poland) <i>Analysis of the corneal deformation and the air pressure curve in Ocular Response Analyzer (ORA) and Corvis Tonometer</i>
11:40	V. Yakushev (Institute for Computer Aided Design, Russian Academy of Sciences, Russian Federation) <i>Simulation of the corneoscleral rigidity in the measurement of intraocular pressure</i>
Session: Vitreoretinal surgery Chair: R. Repetto (Department of Civil, Chemical and Environmental Engineering, University of Genoa, Italy)	
12:00	M. R. Romano (Department of Ophthalmology, Istituto Clinico Humanitas, Milan, Italy) <i>Thermic changes during vitreoretinal surgery</i>
12:20	K. Isakova (Department of Civil, Chemical and Environmental Engineering, University of Genoa, Italy) <i>Stability analysis of the interface between aqueous humour and vitreous substitutes in vitrectomised eyes</i>

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12:40 **Close and lunch**

Some of the main themes discussed are described in the following.

Mechanics of the cornea: Peter Pinsky gave a very interesting invited lecture on structural multiscale models of the cornea. The biomechanics of the cornea was also the subject of seven contributed talks.

Glaucoma: This pathological eye condition is the second largest cause of blindness worldwide (the first in Western countries), and it is well known that mechanics plays a very important role in the pathogenesis and progression of the disease. In this Colloquium we had a very comprehensive overview on the subject from an invited speaker (Claude Burgoyne) and several related contributed talks.

Tear film dynamics: Richard Braun gave a very comprehensive talk concerning the mechanics of tear films after blinking.

Vitreous humour and retinal detachment: the rheological properties of the vitreous humour and its dynamics induced by eye rotations have mechanical implications for the generation of retinal detachment and for drug delivery by injection into the vitreous chamber. The above issues were discussed in nine contributed talks, during which numerical, analytical and experimental results were presented.

Blood flow in the eye: this is a very important issue to understand several pathological conditions of the eye. During the colloquium Philip Luther presented, in his invited lecture, many problems related to blood flow in the eye. Moreover, we had two very interesting contributed talks on this topic.

In the view of the organising committee the meeting was very successful. One of the key reasons for this was the fact that participants had a variety of different backgrounds. After each talk there was extensive discussion that invariably extended during the breaks. The majority of the participants, including young researches, contributed actively to such discussions and the atmosphere was very good and informal. During the Colloquium several possible future collaborative projects were discussed, and, as a result, we anticipate that new collaborations might arise out of the meeting. The talks were overall of a very high quality. Many of the participants commented to the organisers that the meeting was very useful and interesting.

The organising committee wishes to thank the Euromech for making this meeting possible.

Genoa, 31st of July 2013



Rodolfo Repetto

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