CV date	26/11/2019

Part A. PERSONAL INFORMATION

First and Family name	Idan Tuval		
Social Security, Passport, ID number	76918072T	Age	43
Researcher codes	WoS Researcher ID *(*)*	G-9732-2011	
	SCOPUS Author ID*(*)*	6602319292	
	Open Researcher and Contributor ID (ORCID) **	0000-0002-6629-0851	

(*) At least one of these is mandatory
(**) Mandatory

A.1. Current position

Name of University/Institution	IMEDEA (UIB-CSIC)			
Department	Marine Ecology & Physics			
Address and Country	Miquel Marques, 21, 07190, Esporles, Illes Balears			
Phone number	971611910	E-mail	ituval@imedea.uib-csic.es	
Current position	Tenured Lecturer		From	01/09/2017
Key words	Biological physics; dynamical systems; fluid dynamics			

A.2. Education

PhD	University	Year
MsC in Physics	Universidad de Zaragoza	2001
PhD in Physics	Universidad de las islas Baleares	2005

A.3. JCR articles, h Index, thesis supervised…

My research activity has led to more than 40 publications in high-profile referred journals, including one paper in Science, 5 in the Proceedings of the National Academy of Science (US), 13 in Physical Review Letters, 1 Review of Modern Physics and a few book chapters. Several of these have been selected for a research highlight by Nature, Physics, PNAS and the Journal of Cell Biology and one has led to a granted US patent. My work has gathered overall more than 1700 citations WoK (over 2500 citations as for Google Scholar), over 150 citations per year for the last five years and an h-index of 21 (23 as for GS). I have been granted two positively evaluated research periods ("sexenios") with the third one to be applied for at the end of this year.

Part B. CV SUMMARY *(max. 3500 characters, including spaces)*

The scope of my research is to address fundamental problems and cross-disciplinary applications of the motion of bodies immersed in fluid flows with particular interest in those inspired by biological questions. In the last few years I have been specifically interested in the life, motility, development and evolution of aquatic microorganisms using in my research a combination of theoretical and experimental approaches borrowed from modern fluid mechanics, microscopy and dynamical systems theory together with biochemical and cell biological techniques.

Fluids are ubiquitous in biological systems, so it is not surprising that fluid dynamics should play an important role in the physical and chemical processes shaping development and evolution of life forms. It is becoming increasingly clear that the number of genes in the genome of a typical organism is not sufficient to specify the minutiae of all features of its ontogeny. Instead, genetics often acts as a choreographer, guiding development but leaving some aspects to be controlled by physical and chemical means. However, only in a few cases have the strands been teased apart to see exactly how fluid forces operate to guide these processes. One remarkable case is an application of fluid dynamics to an old problem in embryology: the origin of left-right asymmetry in the developing embryo of vertebrates. It was recently discovered that this is mediated by a leftward fluid flow generated in a region known as Hensen's node by a small number of rotating cilia attached to its bottom. A puzzling question was how this rotational movement produces a unidirectional leftward flow. With a simple hydrodynamic model, I showed that the only mechanism compatible with pre-existing left-right

symmetry is to have the axis of rotation of the cilia tilted toward the posterior and, from the observed flow intensity, I computed a tilting angle of 25 degrees. This theoretical prediction, published in PNAS in 2004, was later confirmed experimentally by two different groups in Japan and the United States.
My research funded by a Human Frontier Science Program Cross-disciplinary fellowship, focused on understanding the dynamic synchronization of interacting molecular motors and its hydodynamic consequences for three distinct aquatic organisms. I studied: i) the acto-myosin driven cytoplasmic streaming in the Characean algae and I was able to demonstrate very strong enhancement of mixing within the cell and of nutrient uptake from the environment; ii) the two undulating dynein-driven eukaryotic flagella of the unicellular alga Chlamydomonas reinhardtii and found that Chlamydomonas cells can beat their flagella in two fundamentally distinct modes which are under cellular control but tightly regulated by hydrodynamics, and biochemical noise; iii) and investigated flagellar coordination in Chlamydomonas multicellular descendant, Volvox Carteri, and showed that it achieves concerted responses to environmental stimuli based on an independent response program at the single-cell level in the absence of intercellular communication.
During my previous research experience, I have been strongly impressed by the power of the cross-disciplinary cooperation between physics and biology, not only to progress to the solution of long-standing problems in the life sciences, but also to motivate genuinely new physics. I have approached problems both from theoretical and experimental sides, reaching to the strong conviction that to achieve real progress in this kind of science I must master equally well the theoretical and the experimental practice. On the other hand, my approach has been cross-disciplinary in nature, understanding it should not be a mere process of borrowing/lending techniques between disciplines, but instead a mutual and deep involvement in the ways of thinking and working of each other.

Part C. RELEVANT MERITS

C.1. Publications (including books)

J. Arrieta, M. Polin, R. Saleta-Piersanti & I. Tuval. Light control of localized photo-bioconvection. Physical Review Letters, 123, 158101 (2019).

M. Borgnino, J. Arrieta, G. Boffetta, F. De Lillo & I. Tuval. Turbulence induces clustering and segregation of non-motile, buoyancy-regulating phytoplankton. Journal of the Royal Society Interface, 16, 1742 (2019).

JS. Font-Muñoz, R. Jeanneret, J. Arrieta, S. Anglès, A. Jordi, I. Tuval & G. Basterretxea. Collective sinking promotes selective cell pairing in planktonic pennate diatoms. Proc. Natl. Acad. Sci. (USA) 116, 15997 (2019).

H. Aref, JR. Blake, M Budisic, JHE. Cartwright, HJH. Clercx, U. Feudel, R. Golestanian, E. Gouillart, YL. Guer, GF van Heijst, TS Krasnopolskaya, RS MacKay, VV Meleshko, G. Metcalfe, I. Mezic, APS. de Moura, KE. Omari, O. Piro, MFM. Speetjens, R. Sturman, J-L. Thiffeault & I. Tuval. Frontiers of chaotic advection. Review of Modern Physics, 89, 2 (2017).

This work reviews the present position of and surveys future perspectives in the physics of chaotic advection: the field that emerged three decades ago at the intersection of fluid mechanics and nonlinear dynamics, which encompasses a range of applications with length scales ranging from micrometers to hundreds of kilometers, including systems as diverse as mixing and thermal processing of viscous fluids, microfluidics, biological flows, and oceanographic and atmospheric flows.

J. Arrieta, A. Barreira, M. Chioccioli, M. Polin & I. Tuval. Phototaxis beyond turning: persistent accumulation and response acclimation of the microalga Chlamydomonas reinhardtii. Scientific Reports, 7, 3447 (2017).

J. Arrieta, A. Barreira & I. Tuval. Microscale Patches of Nonmotile Phytoplankton. Physical Review Letters, 114, 128102 (2015).

K.C. Leptos, K. Y. Wan, M. Polin, I. Tuval, A. I. Pesci & R. E. Goldstein. Antiphase Synchronization in a Flagellar-Dominance Mutant of Chlamydomonas. Physical Review Letters, 111, 158101 (2013).

R. E. Goldstein, M. Polin & I. Tuval. Emergence of synchronized beating during the regrowth of eukaryotic flagella. Physical Review Letters, 107, 148103 (2011).

First systematic study of the emergence of synchronisation between two eukaryotic flagella. As flagella regrow after deflagellation, coupling increases and the intervals of synchronous beating lengthen dramatically. The dynamics can be explained with a simple elastohydrodynamic model. I had the original idea together with M.Polin, I devised and carried out the experiments, analysed data, and collaborated on manuscript preparation and submission.

K. Drescher, R. E. Goldstein, N. Michel, M. Polin & I. Tuval. Direct measurement of the flow field around freely swimming microorganisms. Physical Review Letters, 105, 168101 (2010). Selected for a Viewpoint in Physics: D. Saintillan, "A quantitative look into microorganism hydrodynamics". Physics 3, 84 (2010).
First quantitative measurement of the flow field around microorganisms freely swimming in bulk fluid. I contributed to the original idea of the paper; I devised and carried out the experiments and analysed the results for one of the two organisms (Volvox carteri). I contributed to writing the manuscript and dealt with most of the replies to referees.

K. Drescher, R. E. Goldstein & I. Tuval. The Fidelity of Adaptive Phototaxis. Proc. Natl. Acad. Sci. (USA) 107, 11171 (2010).

Selected for highlight by T.J., "In This Issue: Moving to the light". PNAS 107, 11147-11148

R. E. Goldstein, M. Polin & I. Tuval Noise and synchronization in pairs of beating eukaryotic flagella. Physical Review Letters, 103, 168103 (2009).

This paper showed for the first time that noise plays a fundamental role in eukaryotic flagellar dynamics, and that from its accurate study one can estimate parameters of the dynamics that would otherwise be inaccessible. I worked in close collaboration with M. Polin on all aspects of the project, from the original idea to the experimental implementation, data analysis, writing of the manuscript and submission.

M. Polin, I. Tuval, K. Drescher, J. P. Gollub & R. E. Goldstein
Chlamydomonas swims with two "gears" in a eukaryotic version of run-and-tumble locomotion. Science, 325, 487-490 (2009).

Selected for Perspective article: R. Stocker, and W. M. Durham, "Tumbling for Stealth?" Science 325, 400 (2009).

This paper showed for the first time that the regulation of flagellar coordination can lead to a eukaryotic version of the run-and-tumble locomotion previously recognised only in bacteria.

C.2. Research projects and grants

Experimental flume for research in marine ecology (EcoCanal). Ministerio de Ciencia, Innovación y Universidades (2019-2020), 174.175€, PI: I. Tuval

Unravelling phototaxis-photosynthesis connections in a model microalga. Leverhulme Trust (2019-2023), 328.000€, co-IP: Idan Tuval

Chemobrionics. COST Action CA17120 (2018-2022) Scientific Representative: I. Tuval

Dinámica de la gestión de la luz en microalgas mótiles. Beca Leonardo BBVA a investigadores y creadores culturales (2017-2019), 40.000€, PI: I. Tuval

Microfluídica para el estudio del metabolismo celular. Accions especials d'R+D+i del Govern de les Illes Balears (2017). 12.500€, PI: I.Tuval

Iniciativa interdisciplinar sobre las bases dinámicas de los fenómenos biológicos y pre-biológicos. Ministerio de Economía y Competitividad (2017-2019), 130.000€, co-PI: I. Tuval

Dinámica de la Vida II. Ministerio de Economía y Competitividad (2014-2017), 105.000€, co-PI: I. Tuval

Integrative Eco-Mechanics of Diatom Sinking: Cellular Physiology, Complex Advection and the Biological Carbon Pump. Marie Curie Career Integration Grant (2012-2014), 100.000€, PI: I. Tuval

C.4. Patents

Dynamic equilibrium separation, concentration, and mixing apparatus and methods. Inventors: Igor Mezic, Frederic Bottausci, Idan Tuval. Agent: Gates & Cooper LLP Howard Hughes Center - Los Angeles, CA, US. Issued US Patent #: 8182669B2

C.5 Other

Fellowships and Honours:

MC of the COST Action CA17120 (2018-2021)

Invitational Fellowship from the Japan Society for the Promotion of Science (JSPS), (University of Tokyo, Japan, 2019)

Jose Castillejo Mobility Stays Abroad for Young doctors (University of Warwick, UK, 2016)

Santander Iberoamerica Fellowship for Young Professors and Researchers (UNAM, Mexico, 2015)

Member of the COST Action MP1305 Flowing Matter (2014-2017)

NSF award to attend the 2010 International Graduate Training Course in Antarctic Marine Biology (McMurdo Station, Antarctica, 2010)

Best Poster Award Noise and synchronization in pairs of beating eukaryotic flagella (Dynamics in Systems Biology, Aberdeen, UK, 2009)

HFSP Cross-Disciplinary Fellowship (2006-2010)

Award to attend the 18th Meeting of Nobel Laureates (Lindau, Germany, 2006)

Best PhD Award, University of the Balearic Islands (2005)

FPI pre-doctoral Fellowship from the Spanish Ministry of Science and Education (2001-2005)

Professional Service: Referee for Proc. Natl. Acad. Sci. (USA), Nature Communications, Physical Review Letters, Soft Matter, Physical Review E, Journal of the Royal Society Interface, Europhysics Letters, Physics Letters A and JoVE; Assessor for the University of Cambridge Research fellows tribunal; Helper to the Organizing Comitee Dynamics Days Europe XXIV; PhD Thesis Committee Member for the Physics Program, Universidad de Barcelona and UIMP.