MINISTERIO DE CIENCIA E INNOVACIÓN

Cofinanciado por la Unión Europea

AGENCIA ESTATAL DE INVESTIGACIÓN

CURRICULUM VITAE (CVA)

IMPORTANT – The Curriculum Vitae cannot exceed 4 pages. Instructions to fill this document are available in the website.

Part A. PERSONAL INFORMATION

CV date	06/11/2023

First name	Idan		
Family name	Tuval		
Gender (*)	Male	Birth date (dd/mm/yyyy)	19/11/1976
ID number	76918072T		
e-mail	ituval@imedea.uib-csic.es	https://imedea.uib-csic.es/~ituval/	
Open Researcher and Contributor ID (ORCID) (*)		http://orcid.org/0000-0002-6629-0851	

(*) Mandatory

A.1. Current position

Position	Tenured Scientist at CSIC and Deputy director IMEDEA		
Initial date	01/12/2021		
Institution	Mediterranean Institute for Advanced Studies, IMEDEA (UIB-CSIC)		
Department/Center	Marine Ecology		
Country	Spain	Teleph. number	971611910
Key words	Biological physics; dynamical systems; fluid dynamics		

A.2. Previous positions (research activity interuptions, art. 14.2.b))

Period	Position/Institution/Country/Interruption cause
2017-2021	Profesor contratado doctor, UIB, IMEDEA y Dpt. Física
2010-2017	Ramon y Cajal researcher, UIB, IMEDEA y Dpt. Física
2008-2010	PDRA, BBSRC fellow, DAMTP, U of Cambridge (UK)
2006-2008	PDRA, HFSP fellow, DAMTP, U of Cambridge (UK)
2005-2006	PDRA, Quantitative Biology Initiative, BIO5 Institute, U of A (USA)
2001-2005	FPI fellowship, UIB, Dpt. Física

A.3. Education

PhD, Licensed, Graduate	University/Country	Year
MsC in Physics	Universidad de Zaragoza	2001
PhD in Physics	Universidad de las islas Baleares	2005

Part B. CV SUMMARY *(max. 5000 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.
I currently co-lead the physico-biological interactions in the ocean research group (InFiBiO) at IMEDEA, with a research focus on biophysical aspects of marine microbial ecology. 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.
My research activity has led to more than 50 publications in high-profile referred journals, including one paper in Science, 1 in Science Advances, 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 2750 citations WoK (over 4000 citations as for Google Scholar), over 150 citations per year for the last five years and an h-index of 23 (24 as for GS).

Part C. RELEVANT MERITS *(sorted by typology)*

C.1. Publications *(see instructions)*

Williams, S.; Jeanneret, R.; Tuval, I. and Polin, M. Confinement-induced accumulation and spontaneous de-mixing of microscopic active-passive mixtures. Nature Communications, 13, 2041 (2022)

Font-Muñoz, JF.; Sourisseau, M.; Cohen-Sanchez, A.; Tuval, I. and Basterretxea, G. Pelagic diatoms communicate through synchronized beacon natural fluorescence signaling. Science Advances, 7, eabj5230 (2021)

First direct observation of light-mediated communication in marine diatoms.

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)

Experimental proof of the role hydrodynamic interactions during the sinking motion of pennate diatoms play in pairing for sexual reproduction.

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.

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.

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.

R. E. Goldstein, I. Tuval & J. W. van de Meent. Microfluidics of Cytoplasmic Streaming and its Implications for Intracellular Trans- port. Proc. Natl. Acad. Sci. (USA), 105, 3663- 3667 (2008).
Selected for highlight by R.H. Austin, "Nanoscale hydrodynamics in the cell: balancing motorized transport with diffusion". HFSP Journal 2, 262-265 (2008) and for a Viewpoint in Physics: T. Squires, "The inner life of mesoorganisms". Physics 1, 30 (2008).

J. H. E. Cartwright, O. Piro & I. Tuval. Fluid-dynamical basis of the embryonic development of left right asymmetry in vertebrates. Proc. Natl. Acad. Sci. (USA) 101, 19, 7234 (2004).
Selected for highlight by W.A. Wells, "Tilt back to turn left". The Journal of Cell Biology 165, 456 (2004).

C.2. Congress

C.3. Research projects

Desarrollo de un método de control de proliferaciones de algas nocivas basado en sistemas dinámicos (HABSYS). MICINN (2022-2024), 174.800 EUR (PI: Idan Tuval)

Sistema analítico para metabolómica marina (SAMM). MICINN (2022-2023), 873.392 EUR (PI: Gotzon Basterretxea)

Physics of Microbial Motility (PHYMOT). H2020-MSCA-ITN-2020- Innovative Training Networks (2020-2024), 4.106.256 EUR (Coord: Gerhard Gompper; Spanish node: Idan Tuval)

Canal de experimentación para investigación en ecología marina (EcoCanal). Ministerio de Ciencia, Innovación y Universidades (2020-2021), 193.048 EUR (PI: Idan Tuval)

The rheological properties of eukaryotic cilia and flagella. Ministerio de Ciencia, Innovación y Universidades (2020-2022), 188.760 EUR (co- PI: Idan Tuval)

Chemobrionics. COST Action CA17120 (2018-2022), 315.117 EUR (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 EUR. 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 EUR. 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 EUR. co-PI: I. Tuval

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

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

Dynamic synchronization of interacting molecular motors. Human Frontiers Science Program Organization (2006-2010), 107.000 EUR. PI: I. Tuval

Physical Aspects of Evolucionary Transitions to Multicellularity. Biological and Biotechnology Research Council UK (2008-2011), 566.923 GBP. PI: Raymond E. Goldstein

C.4. Contracts, technological or transfer merits

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