

Paul Van Liedekerke, Phd.

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Personal

Nationality: Belgian

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Profile

- **Ingénieur Expert - Research Associate** at **INRIA** de Paris, project “*Mamba*”. Code development and modeling the behavior of soft matter (fluids and solids) and biological Systems (cells, tissues). Physics-based methods and numerical algorithms. Agent-based models.
- **Visiting professor**, K.U.Leuven, Belgium.

Education

- **PhD, Applied Biological Sciences** (K.U.Leuven, Belgium, 2007) - modeling of granular flow. Title : "Study of the granular fertilizers and the centrifugal spreader using Discrete Element Method (DEM) simulations "
- **Post graduate in Environmental Sciences and Technologies** (University of Ghent, 2001). Title : "A statistical study to relate physical parameters and psychological effects in the experience of noise".
- **Master of Physics**, option experimental physics (University of Ghent, Belgium, 1999). Title : "A study of the atmospheric dispersion model HYSPLIT for Kr-85".
- Lower education (lycée): “Industriële Wetenschappen”, Koninklijk Technisch Atheneum Herzele, Belgium (1995).

Experience

- 01/12/2012- now (INRIA):
 - Development of **agent-based** models for (multi-)cellular systems at different scales for investigation of mechanical stress in tumor spheroids and tissues, growth of avascular tumors, mechano-transduction, tissue organization and regeneration. Model validation (collaboration with experimental groups).
 - Co-developer of TiSim, a C++ software project for the modeling multi-cellular systems and tissue quantification (<http://www.msysbio.com/>).
 - (2012 - 2013) INRIA responsible for the European research initiative SEURAT (EU- FP7), to reduce animal testing for new drugs (<http://www.notox-sb.eu/>). Representative for several project meetings
- 2011: **Scientific visitor at EMI Fraunhofer Institute, Freiburg, Germany.** To study impact and damage caused by shock waves on cells and tissues.
- 30/04/2011- 01/12/2012: **Senior Postdoc** at KULeuven: Modeling of the draining properties of complex viscoelastic fluids under free surface conditions. Optimization and product improvement. Bilateral project with Dutch company MOBA.
- 2007-2011: **Postdoc** at KULeuven: Development of a multi-scale modeling framework for the mechanics of cells and tissues. Internal KULeuven project "Multi-scale Mechanics of Fruit Tissue".
- 2006-2007: **Research Engineer** at KULeuven: Study for the improvement of granular flow spread by a new conceptual spinning disc fertilizer spreader. (Bilateral project with BASF, US patent 649967).
- 2001-2006: **Research Engineer and Phd-student** at KULeuven: Model development, conducting simulations and experiments for granular matter flow using the Discrete Element method (DEM). Modeling of multi-body dynamics and contact mechanics.

Teaching

- 2013-2017: Visiting professorship at the KULeuven for the course "Modeling of Tissue Physiology" (Prof. H. Ramon and Prof H. Van Oosterwyck, KULeuven, Belgium).
- 2015-2016: 4 contact hours in master course "Towards the systems biology of multi-cellular tissues: Single-cell-based models and beyond" (Prof. D Drasdo, Paris IV - Jussieu).
- 2008-2009: Teaching assistant for the course "Control engineering" - exercises (by Prof. H. Ramon, KULeuven).

Languages

- Dutch (mother tongue)
- English (advanced)
- French (very good)
- German (basic understanding, took a few classes)

Grants

- **2012 - Co-promotor** of FWO (Fonds voor Wetenschappelijk Onderzoek - Vlaanderen) project : "A multilevel, integrative approach for the study of cellmatrix mechanics and mechanotransduction during cell adhesion" (550.000 Euros).

Awards

- **Best Poster Award:** Odenthal, T.; Smeets, B.; Van Liedekerke, P.; Tijssens, E.; Oosterwyck, V. and Ramon, H. A DEFORMABLE CELL MODEL AND ITS APPLICATION TO INVESTIGATE INITIAL CELL SPREADING International Symposium on Computer Methods in Bio-mechanics and Biomedical Engineering., 2013.

Technical skills

- **Computer**
 - Programming: C/C++ and libraries (Boost, CGal), Python, Git.
 - Matlab, Scilab, Paraview, Maple.
 - GNU/Linux, MS Windows and related programs (Office, Kile,...).
 - Deal.II, a C++ open source FE package (www.dealii.org)
 - Notices of parallel computing: OpenMP, notices of MPI and GPU/Cuda implementations. I implemented a parallel version of Smoothed Particle Hydrodynamics in LAMMPS, a molecular dynamics simulator (http://lammps.sandia.gov/doc/PDF/SPH_LAMMPS_userguide.pdf).
- **Numerical methods**
 - Discrete Element Method (DEM), Smoothed Particle Hydrodynamics (SPH), Finite Element Method (FEM), Finite Differences (FD).
 - Coarse-graining techniques, reaction-diffusion equations.
 - Stochastic differential equations, Brownian motion.
- **Scientific reporting (in English)**
 - Writing of scientific reports and giving oral presentations for government institutions and private companies.
 - Writing of international reviewed journal papers and book chapters.
 - Scientific dissemination to public and private partners.
- **Conduction of experiments**
 - Experimental design.
 - Construction of experimental equipment to validate models (during Phd and Postdoc).
 - Knowledge of small electronic devices, motors, cameras, fast-frame camera.

Interests

Professional

- Modeling and study of the behavior of (living) soft matter, granular matter, fluids.
- Mechanics and adhesion of arbitrary shaped bodies and biological cells, mechano-transduction.
- Validation and hypothesis testing of *in silico* models with experimental data.
- PDEs and Numerical methods: Discrete Element Method (DEM) , Smoothed Particle Hydrodynamics (SPH), Finite Element Method.
- Multi-scale models, coarse-graining techniques, reaction-diffusion equations.

Personal

- Computers, sensors and electronics: *Raspberry Pi* projects.
- Weather forecast models and climate change.
- Sports (cycling).

Collaborations

- **01/07/2016- now:** Experimental biology group of Frederic Lemaigre (Institut de Duve, Belgium): model for study of the development bile ducts in embryo's.
- **01/07/2012- now:** Experimental physics group of prof. Pierre Nassoy (Institute Optique, Bordeaux) on the development of the novel "Cellular Capsule Technique", to analyze the mechanical behavior and fate of tumor cells under confinement using experimental and numerical techniques.
- **01/07/2012- now:** Biomechanics group of prof. Hans Van Oosterwijck (KULeuven) on the development of a computational ECM model to predict mechanical stresses during angiogenesis. Supervision of PhD student Tommy Heck.
- **01/07/2012- now:** Experimental group of P. Chavrier (Institute Curie, Paris) studying invasion patterns in *in-vitro* spheroids embedded in ECM.
- 30/04/2011- 01/12/2012: R&D of company MOBA, The Netherlands.
- 2007-2011: Department of Computer Science, K.U.Leuven (Prof. D. Roose).
- 2006-2007: R&D of company BASF, Germany.
- 2001-2006: R&D of company AMAZONE WERKE, Germany and DELVANO, Belgium.

Supervising of PhD and master students

PhD students

- Assessor of Tommy Heck (Department of Mechanical Engineering, K.U.Leuven). Study on the mechanical interaction between cells and ECM. Title to be assigned, phd degree to be obtained in 2017.
- Co-promotor of ir. Bart Smeedts (Department of Biosystems, K.U.Leuven). "Quantitative study on the influence of process design on the biophysical microenvironment in 3D cell cultures", phd degree obtained in 2015.

- Assessor of Yaidel Reyes Lopez (Department of Computer science, K.U.Leuven). "MPI Parallelization of particle based codes", phd degree to be obtained in 2014.
- Co-promotor of Dr. Tim Odenthal (Department of Biosystems, K.U.Leuven). "Development of an individual cell based model of cell aggregates in bone tissue engineering", phd degree obtained in 2013.
- Assessor of Dr. Jurgen Vangeyte (Department of Biosystems, K.U.Leuven), thesis title "Development and validation of a low cost technique to predict spread patterns of centrifugal fertilizer spreaders.", phd degree obtained in 2013.
- Assessor of Dr. ir. Pieter Gyhysels (Department of Computer science, K.U.Leuven). "Multi-scale modeling of viscoelastic plant tissue", obtained 28 November 2010.

Master students

- supervisor of Ir. Fadil Alitinisik (Master in BIO-Engineering), Master thesis title "Determination of cell mechanical properties by micro-pipette aspiration", degree obtained in 2011.
- supervisor of Ir. Bart Smeets (Master in BIO-Engineering), Master thesis title "Individual-based models of yeast colonies: a discrete element approach", degree obtained in 2010.

Scientific committees and evaluations

- Member of HCERES evaluation committee for the research unit "BIOSP" , INRA, Avignon (France), 10/01/2017.
- Member of scientific committee for particles conference 2017-2019.
- Reviews for international journals: *Physical Biology, Microfluidics and Nanofluidics, Journal of Rheology, Journal of Theoretical Biology, Computer Physics Communications, Applied mathematical Modeling, Engineering Analysis with Boundary Elements, Medical Biological Engineering and Computing, Powder Technology, Biosystems Engineering.*

Organization of events and memberships

- Co-organizer of a mini-symposium (cells and tissues modeling) in the 5th Particles conference in 2017, Hannover, Germany.
- Co-organizer of a mini-symposium (cells and tissues modeling) in the 4th Particles conference in 2015, Barcelona, Spain.
- Co-organizer of LMCC Workshop on "Fundamentals and applications of SPH in science and engineering" , October 25-26, 2010, Leuven, Belgium.
- Co-organizer of 1st international symposium on centrifugal fertilizer spreading, 15-16 September 2005, Leuven, Belgium.
- Membership of "SPHeric", the SPH European Research Interest Community. (<http://spheric-sph.org>)
- Membership of "Lysim", network of twenty German centers and institutions brought together by a funding program of the German Government. (www.lisym.org)

Attended courses (past)

- Colmot10: International Workshop on Statistical Physics and Biology of Collective Motion, Max Planck Institute Dresden, Germany, 8-12 November, 2010 (Poster presentation)
- Course on Nano- and Micro-Mechanics of Living Cell Adhesion, CISM Udine, Italy, June 14-18 (2010).
- Short course on particle based methods, CIMNE, Barcelona, Spain, May 14-1 (2008).
- 39 th Spring school SOFT MATTER, Julich, Germany (2008).

Publications

International journals

1. **Van Liedekerke P.**, J. Neitsch, T. Johann, E. Warnt, and D. Drasdo (2017) Quantifying mechanics and growth of cells in tissues using high resolution computational models (*preprint*).
2. **Van Liedekerke P.**, J. Neitsch, T. Johann, K. Alessandri, P. Nassoy and D. Drasdo (2017) Quantitative modeling identifies robust predictable stress response of growing CT-26 tumor spheroids under variable conditions (*submitted, preprint: <http://www.biorxiv.org/content/biorxiv/early/2017/03/31/122614.full.pdf>*).
3. T. Heck, S. Vanmaercke, P. Bhattacharya, T. Odenthal, H. Ramon, H. Van Oosterwijck and **Van Liedekerke P.** (2017) Modeling ExtraCellular matrix viscoelasticity using non-inertial Smoothed Particle Hydrodynamics (*Comp. Meth. Appl. Mech. Eng.*) 322(1).
4. **Van Liedekerke P.**, M. Palm, N. Jagiella and D. Drasdo (2015) Simulating tissue mechanics with Agent Based Models: concepts and perspectives *J. Comp. Part. mech* 2(4) (*Invited review*).
5. B. Smeets, T. Odenthal, J. Keresztes, S. Vanmaercke, **Van Liedekerke P.**, E. Tijskens, W. Saeys, H. Ramon, H. Van Oosterwijck (2014) Modeling contact interactions between triangulated rounded bodies for the discrete element method. *Comp. Meth. Appl. Mech. Eng.* 275(10).
6. T. Odenthal, B. Smeets, **Van Liedekerke P.**, E. Tijskens, H. Ramon, H. Van Oosterwijck (2013) Contact mechanics of adhesive triangulated bodies and application to a deformable cell model. *Plos Comp. Biol* 9(10).
7. **Van Liedekerke P.**, T. Odenthal, B. Smeets, H. Ramon (2013) Solving microscopic flow problems using Stokes equations in SPH. *Computer Physics Communications* 184(7).
8. Bart M. Nicolai, Ashim K. Datta, Thijs Defraeye, Mulugeta A. Delele, Quang T. Ho, Linus Opara, Herman Ramon, Engelbert Tijskens, Ruud van der Sman, **Paul Van Liedekerke**, Pieter Verboven (2012). Multi-scale Modeling in Food Engineering. *Journal of Food Engineering* 277.
9. Smeets, B., Odenthal, T., Tijskens, E., Roberts, S., Tam, W., **Van Liedekerke, P.**, Van Oosterwyck, H., Ramon, H. (2012). Influence of mechanics on micro-carrier cell expansion: a computational study. *Journal of Tissue Engineering and Regenerative Medicine*: vol. 6. TERMIS World Congress. Vienna, Austria, 5-8 September 2012, 391-392.
10. **Van Liedekerke P.**, Ghysels P., Tijskens E., Samaey G., Roose D. and Ramon H. (2011) The bruising of soft cellular tissue: a particle base simulation approach. *Soft Matter* 7, DOI:10.1039/CoSM01261K.
11. **Van Liedekerke P.**, Ghysels P., Tijskens E., Samaey G., Roose D. and Ramon H. (2010) Particle based model to simulate the micro-mechanics of a spherical biological cell. *Phys. Rev. E* 81(1). **Selected for the Virtual Journal of Biological Physics Research.**
12. **Van Liedekerke P.**, Ghysels P., Tijskens E., Samaey G., Roose D. and Ramon H. (2010) A particle based model to simulate the micro-mechanics of single plant parenchyma cells and aggregates. *Phys. Biol.* 7 026006.
13. Ghysels P., Samaey G., **Van Liedekerke P.**, Tijskens E., Ramon H. and Roose D. (2010) Coarse implicit time integration of a cellular scale particle model for plant tissue deformation". *Int. J. Multiscale Com. Eng.* 8(4).
14. Geris L., **Van Liedekerke P.**, Smeets B., Tijskens E., Ramon H. (2010) A cell based modeling framework for tissue engineering applications. *Journal of Biomechanics* 43, 887-892.
15. Ghysels P., Samaey G., **Van Liedekerke P.**, Tijskens E., Ramon H. and Roose D. (2010) Multi-scale modeling of viscoelastic plant tissue. *Int. J. Multiscale Com. Eng.* 8(4).

16. Ghysels P., Samaey G., Tijskens B., **Van Liedekerke P.**, Ramon H. and Roose D. (2009) Multi-scale simulation of plant tissue deformation using a model for individual cell mechanics. *Phys. Biol.* 6(3).
17. **Van Liedekerke P.**, Tijskens E. and Ramon H. (2009) Discrete Element Simulations of the influence of fertilizer properties on the spread pattern from spinning disc spreaders. *Biosystems Engineering* 102 (4), 392-405.
18. **Van Liedekerke P.**, Tijskens E., Dintwa E.,F. Rioual, J. Vangeyte and Ramon H. (2008) DEM simulations of the particle flow on a centrifugal fertilizer spreader. *Powder Technology* 190(3), 348-360.
19. **Van Liedekerke P.**, Piron E., Vangeyte J., Villette S., Ramon H. and Engelbert Tijskens (2008) Recent results of experimentation and DEM modeling of centrifugal fertilizer spreading. *Granular Matter*, 10(4),247-255.
20. **Van Liedekerke P.**, Tijskens E., Dintwa E., Anthonis J. and Ramon H. (2006) A discrete element model for simulation of a spinning disc fertilizer spreader. I: Single particle simulations *Powder Technology* 170(2), 71-85.
21. Dintwa E., **Van Liedekerke P.**, Tijskens E., Ramon H. (2004) Model for simulation of particle flow on a centrifugal fertilizer spreader. *Biosystems Engineering* 87(4), 407-415.
22. Van Zeebroeck M., Tijskens E., **Van Liedekerke P.**, Deli V., De Baerdemaeker J. and. Ramon H (2003) Determination of the dynamical behaviour of biological materials during impact using a pendulum device *Journal of Sound and Vibration* 266(3), 465-480.

Book chapters

Van Liedekerke P., A. Buttenschoen, D. Drasdo. "Off-Lattice Agent-Based Models for Cell and Tumor Growth: Numerical Methods, Implementation, and Applications" in *Numerical Methods and Advanced Simulation in Biomechanics and Biological processes*, published by Elsevier, to appear in 2017 (Invited chapter).

D. Drasdo, A. Buttenschoen, **Van Liedekerke P.**. "Lattice-based Agent-Based Models for Cell and Tumor Growth: Numerical Methods, Implementation, and Applications" in *Numerical Methods and Advanced Simulation in Biomechanics and Biological processes*, published by Elsevier, to appear in 2017 (Invited chapter).

Van Liedekerke P., Vrindts E., Moshou D., Anthonis J., Bravo C., 2006. Fertilization, weed and pest control. Volume VI: Information technology. CIGR Handbook of agricultural engineering (ISBN 1-892769-54-9).

E. Tijskens, P. Van Liedekerke, H. Ramon, "Modelling to Aid Assessment of Fertilizer Handling and Spreading Characteristics", 2005. Proceeding 553 for the International Fertilizer Society (ISBN 978-0-85310-189-5)

Short letters

1. Van Liedekerke P., Odenthal T. Smeets B., Ramon H. Modeling of low Reynolds flow problems using Stokes equations in SPH. 17th Spheric Newsletter, December 2013.
2. Van Liedekerke P. A combined SPH-DEM model to understand the dynamic behaviour of plant cells. 7th Newsletter, December 2008.

International conference proceedings and seminar presentations (not complete)

1. Paul van liedekerke, "Quantitative modeling identifies robust predictable stress response of growing CT-26 tumor spheroids under variable conditions" Particles Hannover 2017, Hannover, Germany (Invited talk).

2. Paul van liedekerke, "Quantitative modeling identifies robust predictable stress response of growing CT-26 tumor spheroids under variable conditions". Cellmech 2017", Windermere, UK (poster presentation)
3. Paul van liedekerke, "Simulating tissue mechanics with Agent Based Models: concepts and perspectives". ECCOMAS 2016, Crete (talk)
4. Paul van liedekerke, in : Towards a unified framework for benchmarking multi-cellular models and modelling/simulation software, University of Leizig , Germany (**Invited talk**).
5. Paul van liedekerke, Johannes Neitsch, Tim Odenthal, Bart Smeets, Herman Ramon, Hans Van Oostervijck, Dirk Drasdo. Simulation of cell mechanics in a micropipette aspiration experiment using a highly detail model. 9th European Conference on Mathematical and Theoretical Biology (**invited talk** to minisymposium)
6. Van Liedekerke P. "Modeling of tissue at different scales using particle methods" 5th International Conference on Computational Bioengineering, ICCB2013, 11-13 September, Leuven, Belgium (talk)
7. Van Liedekerke P. "Solving Stokes equations using SPH". Third Conference on Particle-Based Methods PARTICLES 2013, 18-20 September, Stuttgart, Germany (**Invited session**).
8. Van Liedekerke P. "Particle methods for simulations in biomechanics and cell mechanics. "Multiscale mechanics group of Prof. Stefan Luding, 6 May 2013, University of Twente, The Netherlands (**Invited talk**).
9. Cardinaels, R., Van de Velde, J., Mathues, W., Van Liedekerke, P., Moldenaers, P. (2013). A rheological characterisation of liquid egg albumen. Inside Food Symposium. Leuven (Belgium), 9-12 april 2013 (pp. 1-6).
10. Van Liedekerke, Particle methods for simulations in biomechanics and cell mechanics. *University of Leipzig, IZBI, Germany, August 6, 2013. (Invited talk)*.
11. Van Liedekerke, Micromechanics in Biological Cells: a Multiscale Modeling Approach. *University of Freiburg, group Prof. Dr. Alexander Blumen, Theoretical Polymer Physics, Germany, May 4, 2011. (Invited talk)*.
12. Van Liedekerke, Micromechanics in Biological Cells: a Multiscale Modeling Approach. *2nd conference on Particle-Based Methods (PARTICLES 2011), Spain, October 26-28, 2011 (Invited session)*.
13. Abera, M., Fanta, S., Verboven, P., Van Liedekerke, P., Nicolai, B., Carmeliet, J. (2011). Virtual Fruit Tissue Generation Using Cell Growth Modelling. In Verstraeten, W. (Ed.), Coppin, P. (Ed.), Sase, S. (Ed.), Van Henten, E. (Ed.), De Melo Abreu, J. (Ed.), Acta Horticulturae: Vol. 919. International horticultural congress. Lisboa, Portugal, August 22-27,2010 (pp. 107-114). Lisbon, Portugal: International Society for Horticultural Science.
14. Van Liedekerke, P. Multiscale applications of SPH in tissue modeling. *Forschungszentrum Juelich (Gerhard Gompper group), Germany, December 1, 2010 (Talk)*.
15. Van Liedekerke, P. Multiscale modeling of cellular tissue with particle methods. *EMI Fraunhofer intitute Freiburg, Germany, September 16, 2010. (Invited talk)*.
16. Van Liedekerke P., Ghysels P., Tijskens E. Samaey G. Roose D. and Ramon H. An SPH-DEM model to simulate the micromechanics of cells and tissues. ECCM 16-21 may 2010, Paris, France (Oral presentation).
17. "Particle based Simulation of agricultural and biological processes". 17-18 November 2009 , Divison of Mathematics, Prof. MAJ Chaplain, University of Dundee (**Invited talk**).

18. Van Liedekerke P., Ghysels P., Tijskens E. Samaey G. Roose D. and Ramon H. A 3D particle model to simulate the micromechanics of a spherical biological cell. Conference Particle Based Methods, 25-27 November 2009, Barcelona, Spain. ISBN 978-84-96736-82-5 (Oral presentation).
19. Van Liedekerke P., Ghysels P., Tijskens E. Samaey G. Roose D. and Ramon H. A particle based model to simulate the dynamics of plant cells. Proceedings of the 4th Spheric Conference on Smooth Particle Hydrodynamics, May 2009, Nantes, France (Oral presentation).
20. Van Liedekerke P., Tijskens E., Dintwa E., Vangeyte J., Ramon H., 2006. DEM for centrifugal spreaders. Multi particle simulations and validations. 2nd international symposium for fertilizer spreading, October 24-25, Montoldre, France (Oral presentation).
21. Van Liedekerke P., Tijskens E., Dintwa E., Vangeyte J., Ramon H., 2005. Discrete element simulations for centrifugal spreaders. Single particle simulations. 1st International symposium for fertilizer spreading, September 10-11, Leuven, Belgium (Oral presentation).
22. Tijskens E., Loodts J., Van Zeebroeck M., Van Liedekerke P., Dintwa E., Ramon H., 2005. Particle Based Simulations with DEMeter++, Acta Horticulturae No.674. Proceedings of Model-IT 2005. International symposium on applications of modelling as an innovative technology in the Agri-Food-Chain. May 29- June 2, Leuven, Belgium.
23. Van Liedekerke P., Tijskens E., Dintwa E., Vangeyte J., Ramon H., 2004. Discrete element simulations for centrifugal spreaders. Modelling single particle trajectories : AgEng 2004 proceedings, September 12-16, leuven, Begium
24. Vangeyte J., Sonck B., Van Liedekerke P. and Ramon H., 2004 Comparison of two methods to measure outlet velocity of fertilizer grains from a rotary disc. AgEng 2004 proceedings, September 12-16, leuven, Begium p336-337.
25. Tijskens E., Loodts J., Van Zeebroeck M., Van Liedekerke P., Dintwa E., Ramon H., 2004. Particle Based Simulations with DEMeter++, Proceedings of Partec2004, International Conference for Particle Technology, Nuremberg, Germany, p16-18.
26. Tijskens E., Van Zeebroeck M., Van linden M., Van Liedekerke P., Dintwa E., Ramon H., 2001. DEM Modelling of Agricultural processes: an overview of recent projects, IMACS/IFAC Fourth International Symposium on Mathematical Modelling and Simulation in Agricultural and Bio-Industries. June 12-14, Haifa, Israel.

Contact Persons

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