

*In Memory of Mag. Dragan Lukman, 11 March 1962 - 19 July 2021*

Words do not obey thoughts and feelings when writing in memory of someone who has been a collaborator for many years, a friend I talked to over short coffees about all open questions of our world: in physics, cosmology, mathematics, about society, human life, about values; we just never talked about personal life.

Dragan Lukman joined us in Koper on my Project on elementary fermion and boson fields (the project at the Department of Physics, Faculty of Mathematics and Physics, University of Ljubljana), when I managed to establish the Institute of Technical and Natural Sciences in Koper (PINT). He also was involved in common projects with industry.

At that time, the Bled workshop was held for the second year. Dragan took over the technical side of editing workshops and proceedings of the workshops up to this year 2021, the 24<sup>th</sup> workshop. He was all the time an excellent helper and a good friend to all.

The first research in the field of physics of elementary fermionic and bosonic fields, in which Dragan participated, were at first published in the proceedings of the workshops "What comes beyond the standard models". They belong to a project entitled *spin-charge-family* theory, which I am developing since 1992, also together with colleagues and students. There are still some articles that are not yet prepared for publication in international journals in which Dragan participated.

An overview of all proceedings can be found on the home page of the Bled Workshops

<http://bsm.fmf.uni-lj.si/bled2021bsm/presentations.html>,

after 2008 also on the Cosmovia forum: <https://bit.ly/bled2021bsm>.

Proceedings are cited in articles published also in international journals in this field, among them those coauthored with Dragan.

A song can say a lot and Astri Kleppe on behalf of all of us, who appreciated Dragan and liked him, wrote the poem, appearing in this Proceedings.

Norma Susana Mankoč Borštnik

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Dragan Lukman was introduced into the research work in the middle of eighties of previous century when Slovenia started with the "1000 Young Researchers Project". After finishing his diploma work at the Department of Physics Dragan decided to expand his field of interest to the field of mathematics. He enrolled the postgraduate course at the Department of Mathematics and simultaneously he participated in the research work at the National Institute of Chemistry as a member of the Laboratory for Molecular Modelling. In due course he accomplished all the necessary steps to attain the degree of master of mathematical sciences. His participation in the scientific work resulted in ten publications in international scientific journals. Dragan was able to cope with the research work in quite diverse fields such as strict statistical mechanics, the application of molecular dynamics simulation of biological systems and even technologically oriented studies of mechanical properties of fullerenes.

Prof. Dr. Branko Borštnik,  
The head of The Laboratory for Molecular Modelling at the National Institute for Chemistry Ljubljana, Slovenia in the period when Dragan Lukman was member of the group

Mag. Dragan Lukman, holding Master of Science degree in Mathematics and Bachelor degree in Physics, both degrees received from University of Ljubljana, has approached me, after important recommendations from Prof. Dr. Norma Mankoč Borštnik, in May 2019 with an interest to apply for a research position in my research project Quantum Localization in Chaotic Systems being carried out at CAMTP - Center for Applied Mathematics and Theoretical Physics of the University of Maribor, funded by the Slovenian Research Agency ARRS. In our first interview with him it was immediately obvious that he has quite wide experience in working with various research groups in Slovenia, predominantly with Norma Mankoč and her coworkers, but also with others, with broad knowledge in physics and mathematics, and in computational physics. Therefore my decision to offer him the job was easy. Thus he has joined my core research group, a part of CAMTP, whose members also are Dr. Qian Wang, Dr. Črt Lozej (my

PhD student at the time) and Dr. Benjamin Batistić (also my former PhD student, 2015, now postdoc). We started to work together with Dragan on 1 June 2019. Our main object of study was the phenomenon of quantum or dynamical localization in classically chaotic systems, one of the central issues in the domain of quantum chaos. More precisely, we have been studying very extensively and deeply the localization phenomena in the so called lemon billiards, a special family of two dimensional billiards with extremely rich behaviour both classically and quantumly. They are important paradigmatic model systems. The selection of billiards was made possible only thanks to the extensive calculations by Črt Lozej in the course of his PhD thesis. Dragan started his work quite enthusiastically, and was using mainly the software codes developed over the many years by Benjamin Batistić and recently very drastically improved and expanded by Črt Lozej. In doing so we were discovering very many exciting results which emerged by our heavy computations, and Dragan was always very careful, fast, responsive and reliable, with good physical insight, presenting the results in a shortest possible time, working every day from early morning until the late afternoon, and even on weekends at home. Based on the results under his cooperation four important papers have been produced, 3 of them already published in excellent journals (Physical Review E, Physics MDPI, Nonlinear Phenomena in Complex Systems), the fourth one just in the progress of writing. Therefore Dragan's contribution to our results is quite essential and appreciated.

Dragan was a very pleasant personality, highly modest and quiet person, always helpful, never complaining, and deeply dedicated to his work, not only at our institute, but also in other groups. We did not know much about his personal life, as he was a very shy person and did not show emotions, but this does not mean that he was not sensible and empathic. The tragic news about his sudden death on his way to work in the early morning on Monday 19 July 2021 was a great shock for all of us. We shall remember him as a wonderful fellow and a very good researcher. Our papers with him are a long lasting remembrance of him.

Prof.Dr. Marko Robnik, member of EASA  
Founder and Director of CAMTP - Center for Applied Mathematics and  
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*Draganu Lukmanu v spomin in zahvalo, 11. marec 1962 - 19. julij 2021*

Prave besede kar ne štečejo v zapis v spomin nekomu, ki je bil dolga leta sodelavec, prijatelj in s katerim sva ob kratkih kavicah prediskutirala vsa odprta vprašanja tega sveta, v fiziki, v kozmologiji, v matematiki, v družbi, v človekovem življenju, o vrednotah, le o osebnem življenju nisva govorila nikoli.

Dragan Lukman se mi je pridružil v Kopru na projektu Fizike osnovnih delcev in polj, Oddelka za fiziko Fakultete za matematiko in fiziko Univerze v Ljubljani, ko mi je uspelo ustanoviti Primorski inštitut za naravoslovne in tehnične vede Koper. Sodeloval je tudi na projektih, ki smo jih razvili z gospodarstvom.

Tedaj je Blejska delavnica tekla že drugo leto. Prevezel je tehnično plat urejanja delavnice in zbornika delavnice vse do letošnje 24. delavnice. Bil je vseskozi izvrsten pomočnik in dober prijatelj vsem.

Prve raziskave na področju fizike osnovnih fermionskih in bozonskih polj, pri katerih je Dragan sodeloval, so bile najprej objavljene v zbornikih delavnic "What comes beyond the standard models". Sodiijo v projekt z naslovom *spin-charge-family* theory, ki ga razvijam, tudi skupaj s sodelavci in študenti, že od leta 1992. Je še nekaj prispevkov, ki še niso dozoreli za objavo v mednarodnih revijah, pri katerih je Dragan sodeloval.

Pregled vseh zbornikov je najti na domači strani Blejskih delavnic <http://bsm.fmf.uni-lj.si/bled2021bsm/presentations.html>, po letu 2008 pa tudi na Cosmovia forum: <https://bit.ly/bled2021bsm>.

V prispevkih zbornikov so citirani članki, ki so, potem ko so dozoreli, objavljeni v mednarodnih revijah s tega področja, tudi tisti v soavtorstvu z Draganom.

Pesem pove lahko zelo veliko in Astri Kleppe je v imenu vseh nas, ki smo Dragana cenili in imeli radi, napisala pesem, ki jo objavljamo v tem zborniku.

Norma Susana Mankoč Borštnik  
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Dragan Lukman se je pridružil moji raziskovalni skupini v Laboratoriju za molekularno modeliranje na Nacionalnem Kemijskem inštitu sredi osmdesetih let prejšnjega stoletja, ko je Slovenija odprla projekt "1000 mladih raziskovalcev", ki je omogočil vključitev podiplomskih študentov v raziskovalno delo. Po diplomi na Oddelku za fiziko, Fakultete za matematiko in fiziko, Univerze v Ljubljani se je Dragan odločil za magistrski študij na Oddelku za matematiko, raziskovalno delo pa je nadaljeval na Kemijskem inštitutu v moji skupini. Pravočasno je opravil vse potrebno za pridobitev stopnje magistra matematičnih znanosti. Sodeloval je pri znanstvenem delu, ki je bilo objavljeno v desetih člankih v mednarodnih znanstvenih revijah. Dragan je sodeloval pri raziskavah na precej raznolikih področjih, kot so stroga statistična mehanika, uporaba molekularne dinamike za simulacijo bioloških sistemov in celo pri tehnološko usmerjenem študiju mehanskih lastnosti fulerenov.

prof. dr. Branko Borštnik,  
dolgoletni vodja laboratorija za molekularno modeliranje na Kemijskem inštitutu v Ljubljani  
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Mag. Dragan Lukman, ki je imel magisterij iz matematike ter diplomu iz fizike z Univerze v Ljubljani, me je kontaktiral, na osnovi pomembnih priporočil Prof. Dr. Norme Mankoč Borštnik, v maju 2019, z zanimanjem za delovno mesto raziskovalca na mojem raziskovalnem projektu Kvantna lokalizacija v kaotičnih sistemih, ki je bil izvajan na CAMTP - Centru za uporabno matematiko in teoretično fiziko Univerze v Mariboru, in je bil financiran s strani ARRS. Že ob prvem intervjuju je postalo nemudoma jasno, da ima kar široke izkušnje v sodelovanju z različnimi raziskovalnimi skupinami v Sloveniji, predvsem z Normo Mankoč Borštnik in njenimi sodelavci, a tudi z drugimi, s širokim znanjem v fiziki in matematiki ter v računski teoretični fiziki. Zato je bila lahka moja odločitev, da mu ponudim zaposlitev. Tako se je pridružil moji jedrni raziskovalni skupini, ki je del CAMTP in katere člani so tudi Dr. Qian Wang, Dr. Črt Lozej (moj tedanji doktorand) in Dr. Benjamin Batistić (tudi moj nekdanji doktorand, 2015, sedaj podoktorski sodelavec). Naše sodelovanje z Draganom

se je pričelo 1. junija 2019. Naš glavni predmet raziskav je bil pojav kvantne ali dinamične lokalizacije v klasičnih kaotičnih sistemih, ena glavnih tem na področju kvantnega kaosa. Natančneje, obširno in poglobljeno smo proučevali lokalizacijske pojave v tako imenovanih limonastih biljardih, ki so posebna družina dvo-dimenzionalnih biljardov z izjemno bogatim vedenjem tako klasično kot kvantno. Le-ti so pomembni paradigmatični modelski sistemi. Izbor teh biljardov je bil omogočen zahvaljujoč obširnim računom Črta Lozeja v teku njegove doktorske disertacije. Dragan je pričel z delom dokaj navdušeno, in je uporabljal v glavnem softverske programe, ki jih je v dolgih letih razvijal in razvil Benjamin Batistić, in ki jih je v zadnjem času zelo korenito izboljšal in razširil Črt Lozej. Na tej poti smo odkrili veliko novih vznemirljivih rezultatov, ki so izšli iz naših masivnih računov, in Dragan je bil vselej zelo skrben, hiter, odziven in zanesljiv, z dobrim fizikalnim vpogledom. Rezultate je predstavil v kar najkrajšem možnem času, pri čemer je delal vsak dan od zgodnjega jutra do poznega popoldneva, pa tudi čez vikend od doma. Na osnovi rezultatov v okviru sodelovanja z njim smo pripravili štiri pomembne članke, trije od njih so že objavljeni v odličnih revijah (Physical Review E, Physics MDPI, Nonlinear Phenomena in Complex Systems), četrti pa je v procesu pisanja. Zato je Draganov prispevek k našim rezultatom bistven in cenjen.

Dragan je bil prijazna osebnost, zelo skromen in tih, zmerom v pomoč, nikoli se ni pritoževal, ter predan svojemu delu, ne samo na našem inštitutu, temveč tudi v drugih skupinah. O njegovem zasebnem življenju nismo vedeli veliko, saj je bil zelo plah, in ni kazal čustev, kar pa ne pomeni, da ni bil senzibilen in empatičen. Tragična novica o njegovi nenadni smrti na njegovi poti na delo zgodaj zjutraj v ponedeljek 19. julija 2021 je bila velik šok za vse nas. Spominjali se ga bomo kot čudovitega kolega in zelo dobrega raziskovalca. Naši skupni članki z njim so trajen spomin nanj.

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