НАСТАВНО-НАУЧНОМ ВЕЋУ ФИЗИЧКОГ
ФАКУЛТЕТА УНИВЕРЗИТЕТА У ВЕОГРАДУ

Пошто смо на 1. седници Наставно-научног Већа Физичког факултета Универзитета у Београду, одржаној 17. октобра 2012. године, одређени за чланове Комисије за припрему извештаја по расписаном конкурсу за избор једног РЕДОВНОГ ПРОФЕСОРА за ужу научну област ФИЗИКА ЈОНИЗОВАНИХ ГАСОВА И ПЛАЗМЕ на Физичком факултету у Београду, подносимо следећи

Р Е Ф Е Р А Т

На конкурс за избор једног РЕДОВНОГ ПРОФЕСОРА за ужу научну област ФИЗИКА ЈОНИЗОВАНИХ ГАСОВА И ПЛАЗМЕ на Физичком факултету у Београду, који је објављен у додатку дневног листа "ДАНАС", ПОСЛОВИ 490, од 07. новембра 2012.године, пријавио се само један кандидат, др МИЛОРАД М. КУРАИЦА, ванредни професор Физичког факултета у Београду.

БИОГРАФИЈА, НАСТАВНА И НАУЧНА АКТИВНОСТ

кандидата др Милорада М. Кураице

1. Основни биографски подаци

Др Милорад М. Кураица је рођен 28. 09. 1960. године у Плавну, општина Книн, Хрватска. Гимназију је завршио у Земуну 1979. године. Дипломирао је на Физичком факултету у Београду 1986. године, Истраживачки смер, опциони блок– Експериментална физика. Исте године заснива радни однос у Институту за физику Физичког факултета и уписује последипломске студије на смеру Физика јонизованих гасова. Магистрирао је 1992. године са темом “Спектроскопска дијагностика тињавог пражњења са равном катодом”. Докторску дисертацију под називом “Развој нових спектроскопских метода за дијагностику тињавог пражњења”, урадио је под руководством професора др Николе Коњевића и одбранио 1998. године. У звање доцента изабран је 01. 07. 1999. године, а реизабран 26. 04. 2005. У звање ванредног професора Физичког факулета за ужу научну област Физика јонизованих гасова и плазме изабран је 28.12.2007. године.

2. Наставна активност

Од заснивања радног односа на Физичком факултету до избора у звање доцента, Милорад М. Кураица је држао Експерименталне вежбе из Физике за студенте биологије, Експерименталне вежбе из Физике за студенте хемије, Експерименталне и рачунске вежбе из Физике за студенте механике, Математичког факултета и експерименталне вежбе из предмета Електромагнетизам, Оптика, Квантна оптика и Физика јонизованих гасова и ласера за студенте Физичког факултета.

После избора у звање доцента др Милорад М. Кураица је држао наставу из више предмета: Физика II, Електромагнетизам и оптика, Физика III, Физика IV (за студенте наставних смерова Физичког факултета) и предмета Физика јонизованих гасова и ласера и Основи физике јонизованих гасова и ласера (за студенте наставних смерова Физичког факултета и студене астрофизике Математичког факултета) као и Квантну оптику за студенте истраживачког смера и смера примењена физика и информатика Физичког факултета. На мастер и докторским студијама држи наставу из неколико предмета. До сада је успешно руководио израдом великог броја дипломских и магистарских радова и био ментор при изради једне докторске дисертације.

Наставну активност др Милорада М. Кураице студенти су оценили просечним оценама 4,6 , 4,6 и 4,8.

Поред успешне наставе на поменутим предметима дао је значајан допринос на развоју неколико нових експерименталних вежби, унапређењу извођења наставе и промоцији физике кроз популарна предавања.

Коаутор је монографије “Површинска обрада одливака алуминијум-силицијум легура”.

3. Научна активност

3.1 Публикације

Др Милорад М. Кураица је до сада објавио 50 радова у међународним часописима, од тога 35 у часописима са импакт фактором већим од 1 (19 од избора у звање ванредног професора).

Коаутор је девет предавања на међународним конференцијама и три на конференцијама националног значаја. Кандидат је до сада објавио 80 радова на међународним конференцијама и 17 на домаћим конференцијама. На основу доступних података ти радови су цитирани више од 317 пута, а њихов укупни импакт фактор је 103,74.

Повремено, на молбу уредника, врши рецензије радова у водећим међународним часописима.

3.2 Учешће на научним пројектима и међународна сарадња

Др Милорад М. Кураица је био руководилац пројекта у области основних истраживања Министарства за науку и животну средину за период 2006 – 2010, под називом “Спектроскопска дијагностика плазме у изворима значајним за примене” (број пројекта 141043), и једног пројекта сарадње са привредом - "Одсумпоравање и денитрификација димних гасова насталих сагоревањем Колубарског лигнита у реалним условима". Тренутно је руководилац пројекта министарства за науку ОИ 171034 за период 2011-2014 под називом "Дијагностика и оптимизација извора плазме значајних за примене" и руководилац потпројекта технолошког развоја ТР33022 под називом

"Интегрисани системи за уклањање штетних састојака дима и развој технологија за реализацију термоелектрана и енергана без аерозагађења".

Активно учествује у реализацији неколико пројеката билатералне међународне сарадње.

Члан је научних комитета више међународних конференција (SPIG, CESPC, PPPT, FSO). Био је председник организационог комитета међународне конференције SPIG XXV (2010) и међународне конференције CESPC IV (2011). Тренутно је председник научног комитета међународне конференције SPIG.

4. Преглед научних резултата

Најзначајније области научног рада др Милорада М. Кураице су следеће:

H1. Спектроскопска дијагностика пражњења

H2. Истраживање облика и аномалног ширења спектралних линија водоника

H3. Развој метода за мерење електричног поља у гасним пражњењима

H4. Истраживање физичких процеса у убрзавајућем каналу квазистационарних акцелератора плазме

H5. Истраживања интеракције млазева плазме (енг. plasma flow) са површинама мета од различитих материјала

H6. Физика баријерних пражњења и њихова примена у третирању водених раствора

H7. Примена баријерних пражњења у третирању текстила

H8. Примена гасних пражњења у третирању емисионих гасова

H9. Физика гасних и/или ласера на металним парама

4.1 H1 [A1, A8, A12, A36, A44, A45]

Првим радом [A1] из ове тематске целине, који је настао као резултат израде магистарске тезе кандидата започета су систематска спектроскопска истраживања абнормалног тињавог пражњења Грим-овог типа на Физичком факултету у Београду. У њему су приказани резултати мерења радијалне расподеле електронске (ексцитационе) температуре T_e, електронске концентрације n_e, температуре (енергије) T_H брзих водоникових атома и гасне температуре T_g у зависности од струје пражњења и растојања од катоде. У литератури су овакви подаци били права реткост па су касније резултати ових мерења искоришћени за теоријско моделовање пражњења Гримовог типа (цитираност поменутог рада, >33).

У раду [A12] је описан експеримент осмишљен са идејом да се за мерење гасне температуре (уместо Фабри-Перо интерферометра) искористи оптогалвански сигнал (ОГ) а калибрација је извршена помоћу профила линије снимљеног симултано, апсорпционом техником. У области негативног светљења добијено је добро слагање са раније измереним вредностима [A1], а на граници са катодним падом ОГ сигнал мења знак, па његово понашање постаје интересантно за даље истраживање.

У раду [A33] поред мерења расподеле електричног поља, приказани су и резултати мерења расподеле ротационих теператураи интензитета линија хелијума и водоника у плазма џету.

4.2 H2 [A2, A6, A9, A10, A21, A22, A25, A28, A36]

Јако проширени профили $H_β$ линије водоника представљају научни интерес кандидата од тренутка када су први пут регистровани [А1] у Гримовом пражњењу у мешавини Ar +H_2. Исти ефекат је примећен и на осталим линијама Балмерове серије водоника [А2], а зависност самог ширења линија од материјала катоде и радног гаса описана је у реф. [А6, А25, А36]. За интерпретацију резултата и објашњење механизма настанака брзих атома H са енергијама далеко изнад 100eV, усвојен је једноставан модел (за разлику од неких далеко егзотичнијих, видети нпр. цитате Mils-а) у којем су јони одговорни за формирање широких крила. Они су ти који, примарно, стичу високе енергије при убрзавању у јаким електричним пољима у пражњењу и предају их затим неутралима у сударима са изменом наелектрисања. Овај модел је касније, дуги низ година, експериментално тестиран и побољшаван мерењима: у пражњењу са деутеријумом (који има мање изражен Доплеров ефекат), [А6], у VUV области спектра (на Лајмановој серији водоника) [А8], са катодама од материјала са различитим рефлексионим коефицијентом (нпр. угљеник и бакар [А6, А25]) и различитим коефицијентом распршивања, при ниским притисцима и високим радним напонима [А28]. Још бољем разумевању механизма аномалног ширења допринела је упоредна анализа овог ефекта у другим изворима као што су шупља катода [А22, А28], пражњење са виртуелном катодом [А22, ВП24], па чак и астрофизичким плазмама [А22].

Коначно је, радом у чијој основи је Монте Карло симулација транспорта брзих атома водоника у тињавом пражњењу [А21] слика о доплеровском механизму ширења и формирања далеких крила Hα линије употпуњена и довођена до квантитативног слагања са резултатима експериментима.

Утицај магнетног поља на профил линије Hα испитиван је у раду [А10].

4.3 Н3 [А3, А4, А5, А16, А15, А23, А29, А30, А33]

Интерес кандидата за Штарковску спектроскопију и употребу линија водоника за мерење електричног поља у пражњењима датира од тренутка када је, захваљујући модификацији Гримовог пражњења са уздужним анодним прорезом, уочио, близу површине катоде, интензивно цепање линије Hγ услед Штарковог ефекта [ВП8]. У истом овом раду, зависност растојања између раздвојених компоненти линије од локалног статичког електричног поља у којем се налази атом емитер, искоришћена је за мерење расподеле електричног поља у области катодног пада потенцијала Гримовог пражњења (први пут описана у литератури). Касније је ова техника поларизационе спектроскопије разрађивана и примењивана коришћењем осталих линија Балмерове серије водоника [А3] за тестирање теорија катодног пада.

Ново поглавље у мерењу електричног поља у пражњењима отворено је имплементацијом методе (коју је кандидат развио у току израде своје докторске дисертације) у којој се користи растојање [А4, А5] између дозвољене и одговарајуће забрањене компоненте линија хелијума, или однос њихових интензитета [А15]. Ова метода је затим успешно коришћена у серији експеримената: за мерење просторне расподеле електричног поља у тињавом пражњењу у хелијуму на атмосферском притиску [А39], у диелектричном бријерном пражњењу (енг. DBD) у хелијуму на повишеном притиску [А16], за приказ еволуције расподеле електричног поља за време пробоја у DBD [А23], за мерење промена у расподели електричног поља услед додавања водоника у DBD пражњење у хелијуму [А30] и мерење расподеле електричног поља у DBD плазма џету који ради у моду плазма метка [А29] итд. Ово последње мерење је показало изузетно добро слагање са теоријским моделом а пре свега са предвиђеном расподелом електричног поља на оси пражњења (видети цитате овог рада). По сазнањима аутора, рад [А23] представља прво публиковано мерење временског развоја (са наносекундном резолуцијом) тињајућег (енг. glow) мода баријерног пражњења у хелијуму.

4.4 H4 [A7, A13, A40, A47]

У току овог циклуса истраживачких активности кандидата, његов научни интерес је усмерен на разумевање физичких процеса који су условили прелазак са електронске на јонску проводност у убрзавајућем каналу квазистационарних акцелератора плазме, који нужно подразумева прелазак са континуалних на секционисане, транспарентне електроде и на тај начин уклањања ограничење на максималну струју пражњења. Истовремено, то подразумева поимање везе између специфичних конструктивних решења електродног система и максимално достигнутих параметара плазме у зони компресије. Тако је у радовима [A7, A13, A40, A47] спектроскопским методама показано да се у потпуно јонизованој водоничној плазми при струјама пражњења реда 80kA могу достићи вредности електронске концентрације веће од $n_e=10^{17}cm^{-3}$, електронске температуре T_e=15000K и брзине плазме v=120km/s.

На основу стечених сазнања у току ових истраживања реализована је оригинална конструкција транспарентног катодног трансформера са шилдовањем (самозаштитом) проводника сопственим магнетним пољем који због тога може да издржи, без ерозије и оштећења, струје пражњења преко 500kA [A7].

4.5 H5 [A11, A24, A41, A43, A46]

Формирањем експерименталне инфраструктуре и пратеће спектроскопске дијагностичке технике постала су неизбежна истраживања интеракције млазева плазме (енг.plasma flow) са површинама мета од различитих материјала. Тако су у радовима [A11, A24, A41, A43, A46] представљени резултати проучавања интеракције снопова плазме са силицијумском чврстом метом. Добијене су потпуно оријентисане, паралелне, периодичне субмикронске структуре на површини силицијума које настају током брзог хлађења. Ова истраживања су значајна за област микроелектронике због могућности формирања нано-цеви, нано-жица, и сл. на силицијумским супстратима.

Резултати испитивања интеракције снопова плазме са алуминијумским клипним легурама, сумирани су у монографији [Б1] и сугеришу слична истраживања и примене за потребе очвршћавања критичних компоненти машинских елемената. Ова активност се веома лако може проширити на истраживања ефеката при интеракцији плазме са материјалом првог зида будућих фузионих реактора, јер су параметри плазме у изворима типа МПК веома блиски параметрима плазме у диверторском каналу токамака.

4.6 H6 [A14, A18, A19, A27, A50]

Своје интересовање за физику баријерних пражњења, поготовао на атмосферском притиску и граници течне и гасне фазе, кандидат манифестује својим првим радом у овој области, [A42], у којем је предложена оригинална конструкција плазма реактора са падајућом воденом "завесом". Тако се кандидату отвара ново поље рада у области хемије плазме. Неравнотежна, хемијски веома активна плазма (баријерно пражњење), која се формира у гасној фази, а завршава на површини течности, сматра се веома перспективним за многе примене. Због тога не чуди што је предложени плазма реактор (тренутно једно од најбољих решења у Европи) испољио своју изузетну ефикасност при уклањању арсена из воде за пиће [A18], при уклањању фенола [A14] и хлорофенола [A14] из воде, деградацији органских боја које се користе у текстилној индустрији [A27, A50], при деградацијеи толуена и тврдокорних нафтних деривата, нпр. андекана [ВП63, ВП67], при деградацији пестицида, хербицида, медикмената и сл.

Посебно треба истаћи ефикасност овог реактора у стерилизацији и активацији воде [ВО4, ВП66].

4.7 H7 [A20, A31, A32, A48, A49, A15, A23, A29, A30, A34]

Последњих година постало је веома популарно третирање текстилних материјала нискотемпературном плазмом са циљем да се изврши замена штетних хемијских једињења која се у овој индустријској грани традиционално користе. Тако су у првом раду из ове области, A48, преставњени резултати третирања влакана конопље у планпараленом DBD-у, са циљем повећања њихове хидрофилности.

За потребе даљих истраживања и третирања текстила, развијен је посебан плазма реактор заснован на DBD-у са слојем зеолита који прекрива једну електроду. У радовима A20 и A49 демонстрирана је његова примена на текстилним материјалима у циљу повећања њихове сорпције сребра и испољавања дуготрајне антимикробне активности.

Извршено је и поређење ефикасности овог плазма реактора са копланарним површинским DBD-ом (развијеним на Масариковом универзитету у Брну) при третирању полипропилена и накнадној сорпцији сребра и злата из раствора. Показано је да се на површини третираних влакана (која се затим потапају у раствор, испирају и суше) формирају честице нано-сребра [A31] и нано-злата [A32].

Рад А34 посвећен је испитивању ефикасности сорпције сребра на вискозним тканинама третираним у DBD у атмосфери различитих гасова.

4.8 Н8 [А26, А35]

Активност кандидата и интерес за решавање еколошких проблема, као што је нпр. емисија азотних и сумпорних оксида у атмосферу применом нискотемпературске плазме (НТП), настао је на бази стеченог искуства у раду са баријерним и корона пражњењима. Због тога су, за потребе једног експеримента у реалним условима, осмишљене и реализоване неколико варијанти плазма реактора, сопствена варијанта електростатичког преципитатора и мокрог амонијачног скрубера. У раду [А26] су публиковани резултати упоредних тестова при директном и индиректном третману димног гаса помоћу плазма реактора конструисаног као батерија од 16 паралелно везаних баријерних пражњења. У раду [А35] описан је лабораторијски модел плазма реактора за третман димних гасова на бази импулсног корона пражњења и дате су његове електричне и спектроскопске карактеристике. За напајање овог реактора развијен је посебан високонапонски импулсни извор (максимални напон 300kV, време пораста предње ивице 40 ns). Ефикасност реактора заједно са извором напајања тестирана је преко његове ефикасности у производњи озона.

4.9 Н9 [А26, А35]

Посебан интереса кандидата ка физици гасних ласера и/или ласера на металним парама изражен је у неколико радова, почевшии од референце [А36], у којој је у Гримовом пражњењу експериментално верификован ефекат резонантног преноса наелектрисања са јона аргона Ar+ на неутрални атом бакра Cu. Тако је отворена могућност за израду ласера на парама бакра у пражњењу Гримовог типа [ВП62], посебно због интензивног спатеровања материјала катоде у овом пражњењу. Даљи рад на тестирању ове могућности настављен је тек после 20-так година у оквиру израде једне докторске дисертације, видети нпр. [ВП69].

5. СПИСАК ПУБЛИКАЦИЈА

А. Радови у међународним часописима

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ЗАКЉУЧАК

На основу анализе резултата укупне активности кандидата, Комисија закључује да ванредни професор др Милорад М. Кураица задовољава све критеријуме за избор у звање редовног професора на Физичком факултету у Београду и са задовољством

ПРЕДЛАЖЕ

Изборном већу Физичког факултета Универзитета у Београду да ванредног професора др Милорада М. Кураицу изабере у звање и на радно место редовног професора Физичког факултета Универзитета у Београду за ужу научну област **ФИЗИКА ЈОНИЗОВАНИХ ГАСОВА И ПЛАЗМЕ.**

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