ISSN 1333-6347
UDC 539.1:929Cindro(497.583)

Izvorni znanstveni rad
Original scientific paper

Znameniti hrvatski fizičar dr. Nikola pl. Cindro (1931. – 2001.)*

The well-known Croatian physicist Dr. Nikola Cindro (1931–2001)*

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Primljeno / *Received*: 2022-07-01; Prihvaćeno / *Accepted*: 2022-10-10

SAŽETAK

U radu se prikazuje život i djelo fizičara dr. Nikole Cindre, čiji su radni vijek i sveukupna djelatnost bili uglavnom vezani uz Hrvatsku (Institut *Ruđer Bošković*), iako je povremeno djelovao i u inozemstvu. Osobita je pozornost posvećena prikazu njegove doktorske disertacije kao i njegovim pedagoškim, znanstvenopopularnim aktivnostima i javnom djelovanju, što u postojećoj literaturi dosad nije bilo predmetom znanstvene obrade. Njegova do sada objavljena autorska znanstvena biografija dopunjena je tako da je dobiven najopsežniji prikaz njegove publicistike.

SUMMARY

The paper presents the life and work of the physicist Dr. Nikola Cindro. Although his life, his career, and all his activities included Croatia (Ruđer Bošković Institute), he was active abroad as well. It gives special attention to his Ph.D. thesis and to his educational activities, popular science activities and public engagements. The existing literature did not present and analyze some of these. The authors updated and supplemented the list of his scientific works, so it is now the most complete list of his publications.

* Članak je djelomice referiran na znanstvenom skupu *Hrvatski prirodoslovci 31,* Split, 25. – 26. studeni 2022.
* *The paper was partially referred at the scientific meeting* Croatian naturalists 31*, Split, Croatia, November 25–26, 2022.*
** Sada u miru. / ***Now retired.*

KLJUČNE RIJEČI

Nikola pl. Cindro
– nuklearna fizika
– reakcije teških iona
– znameniti fizičar i učitelj

1. Životopis Nikole pl. Cindre (Split, 29. VIII. 1931. – Zagreb, 25. III. 2001.)

Nikola Cindro (**slika 1**) rođen je 29. kolovoza 1931. u Splitu. Otac mu je bio Mihovil Cindro, odvjetnik, a majka Ljubica, rođ. Biro. (1) U Splitu je Nikola završio osnovnu školu i realnu gimnaziju s odličnim uspjehom. Njegova obitelj imala je svoje obiteljsko imanje u Strožancu kraj Splita, a posjedovala je i plemićki naslov (**slika 2**). Prema riječima Nikolinog sina Branka, obitelj Cindro jedna je od četiri najstarije obitelji u Hrvatskoj. Nikola je od 1995. osnivač i predsjednik Plemićkoga zbora Hrvatske, iako začetci toga zbora postoje od 1991. (2)

KEYWORDS

Nikola Cindro
– heavy-ion reactions
– nuclear physics
– well-known physicist and teacher

1) Biography: the nobleman Nikola Cindro (Split, August 29, 1931– Zagreb, March 25, 2001)

Nikola Cindro (**Figure 1**) was born on August 29, 1931 in Split. His father's name was Mihovil Cindro, a lawyer, and his mother's name was Ljubica, née Biro. (1) In Split Nikola attended primary school and gymnasium with the best marks. His family had a family estate in Strožanac near Split. Cindros were a noble family and according to the words of Nikola's son Branko they belong to one of the four oldest families in Croatia (**Figure 2**). In 1995 Nikola was the founder and the first president of the Association of Croatian Nobility although one can trace the beginning of this association back to 1991. (2) (In Croatia a nobility has pl. in front of his/hers family name, so N.C. is Nikola pl. Cindro.)

SLIKA 1. **Fotografije N. Cindre s potpisima: lijevo godine 1954., desno 1992.**
FIGURE 1. ***N. Cindro's photos with his signatures: left in 1954, right in 1992***

Godine 1950. Nikola je došao u Zagreb i upisao Prirodoslovno-matematički fakultet (dalje PMF), Odsjek Matematičko-fizički, struku matematika, užu struku: b) primijenjena matematika. Usput je slušao i polagao ispite iz predmeta struke fizika, uže struke: a) teorijska fizika. Od 1951. bio je demonstrator, najprije na struci matematika, a nakon toga na struci fizika. Dana 6. studenoga 1954. diplomirao je obranom diplomskoga rada, na užoj struci: teorijska fizika, s odličnim uspjehom. Naslov diplomskog rada bio je: *Nuklearne strukture (Shell model i A. Bohrov model jezgre)*, a voditelj toga rada bio je dr. Ivan Supek. (3)

Nakon diplomiranja zaposlio se kao asistent u Nuklearno-strukturnoj grupi Instituta *Ruđer Bošković* u Zagrebu. Od 26. rujna 1955. do 30. kolovoza 1956. služio je vojni rok, a nakon toga radio je kao asistent u Odjelu nuklearne fizike II. u istom institutu. Godine 1956./1957. radio je kao honorarni asistent na PMF-u u Zagrebu. Od listopada 1957. bio je na specijalizaciji u USA (na MIT-u dvanaest mjeseci i na University of California dva mjeseca). Za to je vrijeme radio na proučavanju reakcija dobivenih korištenjem ciklotronskog snopa (elastično raspršenje deuterona u sklopu optičkoga modela te reakcije (α, p) (α, d) i na analizi elastičnog raspršenja deuterona u sklopu optičkoga modela. Na temelju tih je rezultata 1959. položio usmeni doktorski ispit i obranio doktorski rad (disertaciju). Tema njegove doktorske disertacije bila je *Elastično raspršenje deuterona od 13,5 i 15 MeV na atomskim jezgrama i analiza u okviru op-*

In 1950 Nikola came to Zagreb where he enrolled at the Faculty of Science (PMF), Department of Mathematics, in the applied mathematics

SLIKA 2. **Plemićki grb obitelji Cindro**
FIGURE 2. ***Coat of arms of the Cindro family***

program. Parallel, he attended lectures in theoretical physics and he took exams as well. From 1951 he was a teaching fellow in the mathematics and later in the physics program. On November 6, 1954 he graduated with the best marks by defending a thesis in the theoretical physics program. The title of the thesis was „Nuclear Structures (Shell Model and A. Bohr's Model of Nucleus)". The thesis supervisor was Dr. Ivan Supek. (3)

After graduation, he found a job as an assistant in the Nuclear Structure group at the Ruđer Bošković Institute in Zagreb. From September 26, 1955 to August 30, 1956 he spent in military service.

tičkog modela. Godine 1959./1960. predavao je kolegij Statistika u sklopu poslijediplomskoga studija na Institutu *Ruđer Bošković*.

Sudjelovao je s referatima na međunarodnim kongresima u Hrvatskoj (Mali Lošinj – 1957., Herceg Novi – 1959. i 1960., Beograd – 1960., Herceg Novi – 1962.) i u inozemstvu (New York – 1960., Napoli – 1960., Krakow – 1963.). Održao je niz pozivnih predavanja, od kojih su najvažnija na University of California, Los Angeles – 1958., University of Minnesota, Minneapolis – 1958. te Institut CISE, Milano – 1959.). Prema podatcima, koje je autorima dao Nikolin sin Branko, dr. Cindro je od 1969. do 1995. održao 35 pozivnih predavanja u Italiji, Rumunjskoj, Poljskoj, SSSR-u, DDR-u, ČSSR-u, Americi, Njemačkoj, Bugarskoj, Japanu i Mađarskoj.Također je u inozemstvu radio na izračunu nuklearnih reakcija u Krakowu (1960.) te Saclayu (1961. i 1962.). Bio je gostujući predavač na Institutu teorijske fizike u Kopenhagenu na poziv prof. N. Bohra. Od 1961. nastavnik je na III. stupnju studija PMF-a u Zagrebu, gdje predaje kolegij Statistički model nuklearnih reakcija. (4) Također je 1961. izabran za izvanrednoga profesora na Elektrotehničkom fakultetu i Kemijsko-tehnološkom fakultetu u Splitu, gdje je do 1964. predavao kolegije Fizika i Uvod u atomsku i nuklearnu fiziku, i bio šef Zavoda za fiziku. Savjet Instituta *Ruđer Bošković* izabrao ga je godine 1961. u znanstvenog suradnika, 1963. u višeg znanstvenog suradnika te 1970. za znanstvenog savjetnika. (5, 6)

After that, he was employed as an assistant in the Department of Nuclear Physics II at the same institute. In the year 1956/57 he was working as an honorary assistant at PMF in Zagreb. From October 1957 he was in the USA at MIT for twelve months and at the University of California for two months. During that time he researched the reactions obtained by cyclotron beams: elastic deuteron scattering within the optical model, reactions (α, p) and (α, d) and the elastic scattering of deuterons within the optical model. Based on this research in 1959 he passed the oral doctoral exam and defended his Ph.D. thesis with the title „Elastic scattering of deuterons of 13.5 and 15 MeV on atomic nuclei and the analysis within the optical model". In the year 1959/60 he was lecturing in the course „Statistics" within a graduate program at the Ruđer Bošković Institute.

He participated with contributions to different international conferences in Croatia and abroad: Mali Lošinj in 1957, Herceg Novi in 1959, 1960 and 1962, Belgrade in 1960, New York in 1960, Naples in 1960, Krakow in 1963. He lectured as an invited speaker at different institutes such as the University of California, Los Angeles (1958), the University of Minnesota, Minneapolis (1958), Institut CISE, Milano (1959) and others. His son Branko says that Nikola Cindro gave 35 invited talks and lectures in Italy, Romania, Poland, USSR, DDR, USA, ČSSR, Germany, Bulgaria, Japan and Hungary between 1969 and 1995.

In Krakow (1960) and at Saclay (1961, 1962) he was doing research on different nuclear reactions. By invitation of professor Niels Bohr, he was the visiting lecturer at the Institute of Theoretical Physics in Kopenhagen. From 1961 at the University of Zagreb, he was lecturing in the course „Sta-

Godine 1965. Cindro je otišao u poznati laboratorij iz nuklearne fizike i fizike teških iona CEN Saclay, Francuska, gdje je proveo dvije godine radeći na strukturi sferičnih jezgri. Radovi na otkriću tzv. „core" stanja atomske jezgre kao i rad na uočavanju važnosti tzv. jednostavnih konfiguracija u strukturi atomske jezgre donijeli su mu 1967. francusko priznanje reda za znanstvene zasluge *Chevalier de l' Ordre du Mérite Scientifique*. Osim toga, godine 1997. dobio je odličje francuske vlade *Officier dans l´Ordre des Palmes Academiques* kao i hrvatska odličja *Danica Hrvatska* s likom Ruđera Boškovića, 1996. i *Zlatni grb grada Splita*, 1999.

Nakon povratka u Zagreb radi na neutronskoj fizici i usavršavanju ekperimentalnih metoda. Također je predavao nuklearne fizike na međunarodnim školama Villara (Švicarska, 1965.) Trst (1969.), Predeal (Rumunjska, 1970.), Rudziska (Poljska, 1971.), Mikolajki (1973.), Alusta (SSSR, 1974.), Varenna (Italija, 1974.), Zakopane (Poljska, 1975). Bio je predsjedatelj i pozvani referent na međunarodnim kongresima: Heidelberg (1966. i 1969.), St. Malo (1968.), La Cassacia (1970.), Budapest (1972.), Colby, USA (1972.), Smolenice (1974.).

Od 1972. voditelj je Laboratorija za nuklearnu spektroskopiju, kasnije se bavi nuklearnom fizikom teških iona u preimenovanom laboratoriju, gdje zajedno s F. Cocuem i drugima eksperimentalno potvrđuje fragmentaciju nuklearnih teškoionskih rezonancija (1977.), a s F. Haasom i D. Freeemanom eksperimentalno dokazuje postojanje nuklearnog Landau-Zenetistical model of nuclear reactions" at the graduate level. (4) Also in 1961 he was elected to the position of associate professor at the Faculty of Electrical Engineering and at the Chemical Technology Department in Split. In Split, he was lecturing „Physics"and „An Introduction to Atomic and Nuclear Physics" at the same time as the Head of the Physics department.

In the year 1961. he was elected to the position of research associate by the Ruđer Bošković Institute. In 1963 he advanced to a higher research associate and in 1970 he was elected to the position of a research adviser. In the year 1965, he left to the well-known nuclear physics laboratory and heavy ions physics CEN Saclay in France. He spent two years there working on a structure of the spherical nuclei. For the discovery of the „core" states of atomic nuclei as well as recognizing the importance of the so-called simple configurations in the structure of atomic nuclei he was awarded Chevalier de l'Ordre du Mérite Scientifique (1967), a French award for scientific achievements. Also in 1997 by the French government he was awarded the title Officier Dans l'Ordre des Palmes Académiques. In 1996 he was awarded by the Croatian government the Croatian honorary medal Danica Hrvatska with a figure of Ruđer Bošković, and two years later he got The golden coat of arms of the city Split.

After his return to Zagreb, he was working on the physics of neutrons and on the advancement of experimental methods. He was lecturing nuclear physics in summer schools in Villara, Switzerland (1965), Trieste (1969), Predeal, Romania (1970), Rudziska, Poland (1971) Mikolajki (1973), Alusta, USSR (1974), Varenna, Italy (1974) and Zakopane, Poland (1975).

rova efekta (1983). Autor je modela nuklearnih molekularnih rezonancija (1978. i 1983.) (7, 8) Njegov rad na području fizike teških iona pridonio je uspješnom prijenosu tih istraživanja i na ostale hrvatske fizičare te je tako odgojena skupina fizičara poznata kao Zagrebačka škola teškoionske fizike.

Godine 1969./1973. bio je izvanredni profesor na Elektrotehničkom fakultetu u Zagrebu, a predavao je i na Građevinskim fakultetima u Splitu i Zagrebu (1974./1977.). Od 1988. je redoviti profesor na Građevinskom fakultetu u Zagrebu, 1980. gostujući je profesor na Sveučilištu u Frankfurtu na Majni, 1985./1986. na Sveučilištu Duke, 1986./1987. je gostujući profesor na Sveučilištu u Strasbourgu, a 1988./1989. u Frankfurtu/M. (6, 8) Na poslijediplomskoj nastavi na PMF-u na Sveučilištu u Zagrebu predavao je predmet Nuklearne reakcije, a predmet Odabrana poglavlja nuklearne fizike na Fakultetu elektrotehnike, strojarstva i brodogradnje Sveučilišta u Splitu. Također je predavao kolegij *Schwerionenphysik* na *Graduirterkoleg* Giessen – Frankfurt/M, Darmstadt, 1991. i kolegij *A Course on Nuclear Reactions: Formalism; reaction models*. CRN/COURS 87/01 na Universite Louis Pasteur, Strasbourg 1986./1987. – temeljem kojeg je napisan i službeni udžbenik.

Prema istraživanjima sina Branka, Nikola Cindro je u razdobljima 1969./1976. i 1983./1997. održao 51 znanstveno predavanje u Francuskoj, SAD-u, Njemačkoj, Italiji, Japanu, Izraelu, Mađarskoj i Češkoj. Tome treba dodati 18 znanstveno-po-

He was an invited lecturer and chairman of international congresses in Heidelberg (1966 and 1969), St. Malo (1968), La Cassacia (1970), Budapest (1972), Colby, USA (1972), Smolenice (1974). In 1972 he was appointed the leader of the Laboratory for nuclear spectroscopy. Later when his interest shifted towards heavy ion physics the name of the laboratory was changed and there in collaboration with F. Cocu and others, he experimentally confirmed fragmentation of the nuclear heavy ion resonances (1977). In collaboration with F. Haas and D. Freeman, he proved experimentally the existence of the nuclear Landau-Zener effect (1983). He authored the model of nuclear molecular resonances (1978 and 1983). His research on heavy ion physics has helped to transfer the knowledge of heavy ion physics to the Croatian physics community and as a consequence of that a successful group of heavy ion physicists was formed known as the „Zagreb school of heavy ion physics".

From the year 1969 to 1973 he was elected an associate professor in physics at the Faculty of Electrical Engineering in Zagreb. He was also lecturing at the Civil engineering faculties in Zagreb and Split. From 1988 he was a full professor in physics at the Civil engineering faculty in Zagreb. He was a visiting professor at the University in Frankfurt/Main (1985/86 and 1988/89), Duke University (1986/87) and University Strasbourg (1988/89). At the Zagreb University, Faculty of Science he was lecturing the course Nuclear reaction and Nuclear Physics – Special Topics at the Split University. He was also lecturing the course Schwerionenphysik on Graduiertenkolleg Gießen-Frankfurt/M, Darmstadt, in 1991 and the course with the title Course on Nuclear Reactions: Formalism; reaction

pularnih predavanja održanih u razdoblju 1982./1995. Sin Branko također naglašava da je njegov otac bio recenzent uglednih časopisa poput *Nuclear Physics A*, *Zeitschrift für Physik A*, *Hadrons and Nuclei*, *Journal of Physics G*, *Nucl. and Particle Physics*, *Physics Letters B*, *North Holland*, *Physical Review (C)* i *Physical Review Letters*.

Nikola Cindro bio je predsjednik i potpredsjednik Društva matematičara i fizičara SR Hrvatske (1968. – 1972.). Također je u Europskom fizičkom društvu bio član Izvršnoga savjeta (1969. – 1974.), Izvršnog odbora (1971. – 1973.), a 1973. –1974. i potpredsjednik toga društva. U razdoblju 1971. – 1975. potpredsjednik je Nuklearno-fizičkog odjela Europskog fizičkog društva. U Hrvatskom fizikalnom društvu bio je član Izvršnog odbora od 1992., a bio je i član Talijanskog fizičkog društva. Uza sve to razvio je i zapaženu djelatnost u brojnim odborima i povjerenstvima: Odboru za nominiranje kandidata za nagradu *Japan prize of Science and Technology* (1985.), Organizacijskom odboru proslave 40-godišnjice Instituta *Ruđer Bošković* (1990.), Matičnom povjerenstvu za područje fizike imenovan je od strane Skupštine zajednice hrvatskih sveučilišta (1993.), Saborskom odboru za dodjelu nagrada Ruđer Bošković (1993.), Saborskom odboru za dodjelu državnih nagrada za znanost (četverogodišnji mandat počev od 1996.).

Osim već spomenutoga francuskog priznanja 1967., dobio je i nagradu Martin-Marietta zajedno s grupom istraživača (1992.), kao i nagradu Instituta *Ruđer Bošković* (1990.) i Nagradu Hrvatske akamodels.CRN/COURS 87/01 at Universite Louis Pasteur, Strasbourg (1986/87). Following his lecture, the official textbook was published. According to the words of Nikola's son Branko, Nikola gave 51 scientific lectures in France, USA, Germany, Italy, Japan, Israel, Hungary and the Czech Republic. Apart from that, he gave 18 public lectures on popular science in the period from 1982 to 1995. According to his son Branko, Nikola was refereeing for eminent journals like *Nuclear Physics A*, *Zeitschrift für Physik A*, *Hadrons and Nuclei*, *Journal of Physics G*, *Nucl. and Particle Physics*, *Physics Letters B*, *North Holland*, *Physical Review (C)* and *Physical Review Letters*.

Nikola Cindro was the president and vice president of the Society of Mathematicians and Physicists of the Republic of Croatia (1969–1972). Also, he was a member of the Executive Council of the European Physics Society (1969–1974), a member of the Executive Board (1971–1973) and the vice president of the Society (1973/74). From 1971 to 1975 he was the vice president of the Nuclear division of the European Physical Society. In the Croatian Physical Society, he was a member of the Executive Board from 1992. He was also a member of the Italian Physical Society. He was active in different boards and committees: a member of the nominee board for candidates for the „Japan prize for Science and Technology" (1985), an organizational board for the 40th Anniversary of the Ruđer Bošković Institute, a member of the Elective committee for physics, nominated by the Assembly of Croatian universities, member of the Parliamentary nominee board for the award „Ruđer Bošković" (1993), member of the Parliamentary nominee board for the state award for science (four years term started in 1996).

demije znanosti i umjetnosti za prirodne znanosti i matematiku za 1994. koju je dijelio s dr. Beneom Nižićem. (6, 9) Također je proglašen počasnim profesorom Fakulteta elektrotehnike, strojarstva i brodogradnje Sveučilišta u Splitu i počasnim profesorom Fakulteta prirodoslovno-matematičkih znanosti i odgojnih područja Sveučilišta u Splitu. Nagrađen je i za životno djelo nagradom Poglavarstva općine Podstrana.

Godine 1958. oženio se Nikola Cindro sa Željkom rođ. Knežević. Bračni par Cindro ima troje djece: Branka, rođenog 1960., Jasnu, rođenu 1961. i Michela, rođenog 1967. (10)

Dana 31. prosinca 1996. prestao je ugovor o radu između Nikole Cindre i Instituta *Ruđer Bošković* jer je te godine navršio 65 godina života. Nakon toga je s Institutom sklopio ugovor o radu na određeno vrijeme, koji je otkazao zbog odlaska u starosnu mirovinu. Sporazumom o prestanku ugovora o radu N. Cindro i Institut usuglasili su se da će ugovor o radu prestati 30. lipnja 1998., a pravo na starosnu mirovinu priznato mu je 1. srpnja 1998. (11) I nakon toga aktivno je djelovao kao vanjski suradnik na Fakultetu prirodoslovno-matematičkih znanosti i odgojnih područja u Splitu.

Na novinarski upit o njegovu najznačajnijem otkriću Cindro je izjavio: „... Moje se ime najviše vezuje uz nešto što se naziva – nuklearne molekule. Što su to nuklearne molekule? U atomskoj jezgri postoje nukleoni, a to su protoni i neutroni... Nuklearne molekule su rezultat spoznaje da se ti nukleoni u jezgrama ne

Apart from the already mentioned French awards in 1967, Nikola Cindro was awarded the Martin-Marietta award in 1992, together with a research group. In the year 1990 the Ruđer Bošković Institute Award was given to N. Cindro, and the Croatian Academy of Sciences Award in 1994. N. Cindro shared with Dr. Bene Nižić. The Faculty of Sciences and Electrical Engineering, Mechanical Engineering and Shipbuilding of the Split University awarded him honorary professor status. By the municipality Government of Podstrana, he was awarded the lifetime achievement award.

In the year 1958 Nikola pl. Cindro married Željka nee Knežević. They have a son Branko born in 1960, a daughter Jasna (1961) and a son Michel (1967).

On December 31, 1996 Nikola Cindro retired after that year he was 65 years old. After retirement, the Institute Ruđer Bošković and N. Cindro signed a short term contract of collaboration. After two years N. Cindro and the Institute came to an agreement to terminate the collaboration and N. Cindro retired on June 30, 1998. He got his pension on July 1, 1998. At the Split University, Faculty of Sciences and Education he continued to teach as an external associate.

In an interview with the press N. Cindro was asked about his most important discovery, and his reply was: „My name is often tied to something that is called the nuclear molecules. What are the nuclear molecules? In an atomic nucleus there exist nucleons and these are protons and neutrons. Nuclear molecules are the result of cognition that these nucleons do not behave erratically but that they form smaller groups, clusters. And these clusters have the form of molecules. My contribution to this notion is that these kinds of structures in

ponašaju bilo kako. Nego da se sklapaju u manje nakupine. U grozdove. I da te nakupine imaju oblik molekule... I ono što sam ja pridonio da se otkrije jest to da takve složene strukture u atomskim jezgrama, koje podsjećaju na molekule, postoje u čitavom nizu jezgara, da nisu vezane samo za dvije, tri jezgre." (12)

Nikola pl. Cindro umro je 25. ožujka 2001. u Zagrebu, a tri dana kasnije ukopan je na groblju Lovrinac u Splitu.

2. O doktorskoj disertaciji Nikole Cindre

Ako se usporedi postignuće Nikole Cindre s tada važećim Zakonom o doktoratu nauka iz 1955. (13) može se uočiti da je u tom postupku stjecanja doktorata prošao sve faze. Naime, on je imao uvjet za stjecanje doktorata znanosti jer je posjedovao diplomu PMF-a o završetku propisane znanosti na tom fakultetu, pa je mogao steći doktorat na istom fakultetu i to iz iste znanstvene discipline (fizike). Dana 30. siječnja 1959. prijavom svoje disertacije i predajom izrađene disertacije u deset primjeraka fakultetu vrlo lako je ostvario prvu fazu. Fakultetsko vijeće PMF-a je na svojoj sjednici 26. ožujka 1959. odredilo komisiju za ocjenu disertacije i područja usmenoga doktorskog ispita i to: detekcija nuklearnog zračenja, prolaz nuklearnog zračenja kroz tvar i nuklearni modeli. Time je ostvarena druga faza. Treća faza stjecanja doktorata znanosti ostvarena je na način da je Fakultetsko vijeće PMF-a na svojoj sjednici 25. lipnja 1959. prihvatilo izvješće komisije za ocjenu doktorske di-

atomic nuclei, which remind us of molecules, exist in a whole bunch of nuclei and that they are not connected to only two or three nuclei."

Nikola pl. Cindro died on March 25, 2001 in Zagreb and three days later he was buried in the Lovrinac cemetery in Split.

2) Doctoral Thesis of Nikola pl. Cindro

If one compares the achievements of Nikola Cindro with the then valid Doctoral law from 1955 (13) it is evident that N. Cindro fulfilled all the required phases. He had all the prerequisites for a doctoral degree having a Faculty of Sciences diploma and he could have obtained his doctoral degree at the same faculty in the same field – physics. So he announced his dissertation and submitted ten required copies on January 30, 1959 to complete the first phase of the procedure. The Faculty Council in the session on March 26 1959 appointed a committee for the evaluation of the dissertation and defined topics for the oral doctoral-qualifying exam: detection of nuclear radiation, the transition of nuclear radiation through the material, and nuclear models. It was the second phase of the procedure. In the third phase the Faculty Council in the session on June 25, 1959 accepted the report of the committee for evaluation and appointed a committee for the oral qualifying exam. The members of the examining committee were Dr. Mladen Paić, president, Dr. Ivan Supek, a member, and Dr. Branimir Marković, a member. In agreement with N. Cindro, the oral exam and defence was held on July 3, 1959. (**Figure 3**). According to the documentation N. Cindro was asked the following questions: ionizing chamber, fission chamber, deexcitation of an ex-

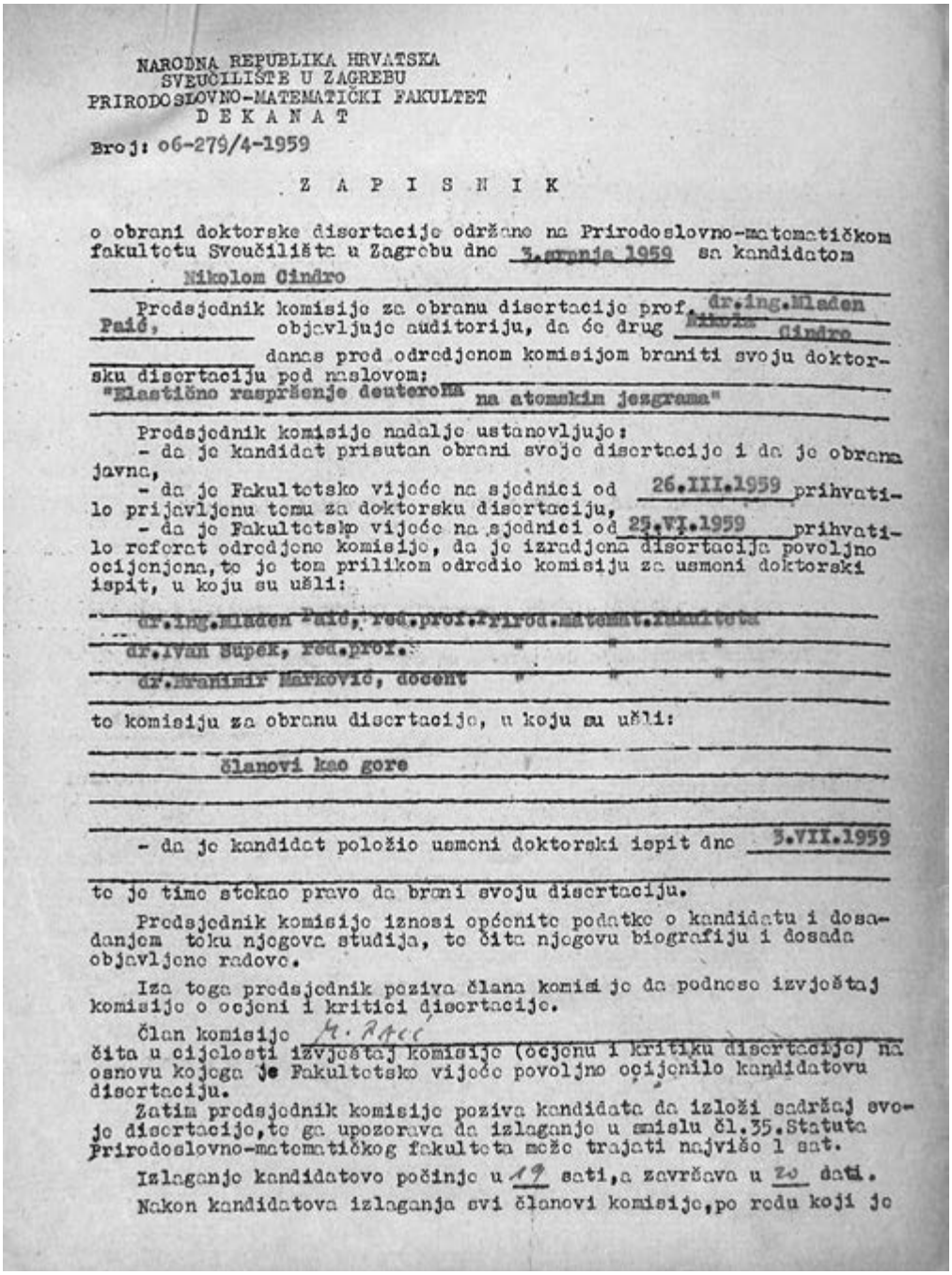
sertacije te izabralo komisiju za usmeni ispit. Komisija je bila u sastavu: dr. Mladen Paić, predsjednik; dr. Ivan Supek, član; dr. Branimir Marković, član. U dogovoru s N. Cindrom održan je usmeni ispit 3. srpnja 1959. Prema Zapisniku s toga ispita Cindri su postavljena pitanja: ionizacijska komora, fiziona komora, deekscitacija uzbuđenog atoma, model kapljice, potencijal belt modela, teorije potencijala, prolaz gama zraka kroz tvar – na koja je Cindro uspješno odgovorio i položio taj ispit te tako ostvario četvrtu fazu postupka. Odmah nakon usmenog ispita održana je i obrana disertacije pred istom komisijom. Prema zapisniku o obrani (**slika 3**), Cindro je u trajanju od jednog sata izložio svoju disertaciju te nakon postavljenih pitanja za pola sata s uspjehom obranio svoju doktorsku disertaciju i okončao petu fazu postupka. Šesta faza bila je najlakša jer se radilo o promociji na kojoj se trebalo samo pojaviti. Dana 7. srpnja 1959. Dekanat PMF-a izvijestio je Rektorat Sveučilišta u Zagrebu da je Nikola Cindro obranio svoju doktorsku disertaciju, uz zamolbu da Rektorat provede postupak promoviranja Nikole Cindre na znanstveni stupanj doktora fizičkih znanosti. (14)

Potpune jasnoće radi potrebno je razjasniti što se, prema navedenom Zakonu, smatralo doktorskom disertacijom. Ta je disertacija morala biti samostalan znanstveni rad i trebala je predstavljati prilog znanosti. Na usmenoj obrani te disertacije kandidat je trebao pokazati da potpuno vlada materijom koju je obradio i da obrazloži i obrani znanstvene zaključke do kojih je u svom radu došao.

cited atom, drop model, the potential of the belt model, the potential theory and the transition of gamma rays through the material. For all questions N. Cindro gave satisfying answers. So he completed the fourth phase. Immediately after the qualifying exam in front of the same committee, N. Cindro successfully defended his thesis. Within one hour he presented his dissertation and by that, he completed the fifth phase. The sixth phase was the easiest one since it was the promotion. On July 7, 1959 the Dean of the Faculty of Sciences reported to the Rector of Zagreb University that Nikola Cindro had successfully defended his dissertation and the Dean asked the Rector to promote N. Cindro to the scientific degree: doctor of physical sciences. (14)

In order to clarify the issue it must be clarified what was considered a doctoral thesis – dissertation – according to the valid Law mentioned before. A dissertation had to be an original, independent scientific achievement. It had to contribute to science. At the oral defence of the thesis, a candidate had to show that he mastered the subject which was the main topic in his dissertation and he had to explain and defend scientific results and conclusions which stemmed from his research. Apart from this formal explanation the content of his defence had to be built into the doctoral thesis.

In N. Cindro's dissertation the energy angular distributions of scattered deuterons at 13.5 and 15 MeV on about 20 nuclei from Al to Pb are given. The results show deviations from the Rutherford scattering and peaks characteristic of optical models. Light elements show a considerable relative increase of the cross section for backward angles. It was noticed as well that Nishid's theory which ex-



NARODNA REPUBLIKA HRVATSKA
SVEUČILIŠTE U ZAGREBU
PRIRODOSLOVNO-MATEMATIČKI FAKULTET
D E K A N A T

Broj: 06-279/4-1959

Z A P I S N I K

o obrani doktorske disertacije održane na Prirodoslovno-matematičkom fakultetu Sveučilišta u Zagrebu dne 3.srpnja 1959 sa kandidatom Nikolom Cindro

Predsjednik komisije za obranu disertacije prof. dr.ing.Mladen Paić, objavljuje auditoriju, da će drug Nikola Cindro danas pred odredjenom komisijom braniti svoju doktorsku disertaciju pod naslovom:
"Elastično raspršenje deuterona na atomskim jezgrama"

Predsjednik komisije nadalje ustanovljuje:
- da je kandidat prisutan obrani svoje disertacije i da je obrana javna,
- da je Fakultetsko vijeće na sjednici od 26.III.1959 prihvatilo prijavljenu temu za doktorsku disertaciju,
- da je Fakultetsko vijeće na sjednici od 25.VI.1959 prihvatilo referat odredjene komisije, da je izradjena disertacija povoljno ocijenjena, te je tom prilikom odredio komisiju za usmeni doktorski ispit, u koju su ušli:

dr.ing.Mladen Paić, red.prof.Prirod.matemat.fakulteta
dr.Ivan Supek, red.prof. " " "
dr.Branimir Marković, docent " " "

te komisiju za obranu disertacije, u koju su ušli:

članovi kao gore

- da je kandidat položio usmeni doktorski ispit dne 3.VII.1959

te je time stekao pravo da brani svoju disertaciju.

Predsjednik komisije iznosi općenite podatke o kandidatu i dosadanjem toku njegova studija, te čita njegovu biografiju i dosada objavljene radove.

Iza toga predsjednik poziva člana komisije da podnese izvještaj komisije o ocjeni i kritici disertacije.

Član komisije M. Paić čita u cijelosti izvještaj komisije (ocjenu i kritiku disertacije) na osnovu kojega je Fakultetsko vijeće povoljno ocijenilo kandidatovu disertaciju.

Zatim predsjednik komisije poziva kandidata da izloži sadržaj svoje disertacije, te ga upozorava da izlaganje u smislu čl.35.Statuta Prirodoslovno-matematičkog fakulteta može trajati najviše 1 sat.

Izlaganje kandidatovo počinje u 19 sati, a završava u 20 sati.

Nakon kandidatova izlaganja svi članovi komisije, po redu koji je

SLIKA 3. **Zapisnik o obrani doktorske disertacije za kandidata Nikolu Cindru**
FIGURE 3. ***Official record of the doctoral dissertation defence of the candidate Nikola Cindro***

Osim toga formalnog objašnjenja treba nešto sadržajno iznijeti i o samoj disertaciji. U disertaciji su dane angularne distribucije energije elastično raspršenih deuterona energija 13,5 i 15 MeV na oko 20 jezgara od aluminija do olova. Rezultati pokazuju odstupanje od Rutherfordova raspršenja i vrhove karakteristične za optičke modele. Laki elementi pokazuju znatan relativni porast udarnoga presjeka za stražnje kutove. Također je uočeno da se teorija Nishide, koji tumači odstupanja udarnih presjeka elastičnog raspršenja od Rutherfordove formule, električnim cijepanjem deuterona ne slaže s eksperimentalnim rezultatima. U radu prikazana analiza, u okviru optičkoga modela, prva je sistematska analiza deuteronskoga elastičnog raspršenja. Opći zaključak je da se optički model nuklearnih reakcija sasvim pouzdano može primijeniti i na deuteronsko raspršenje.

2.1. Pregled nekih znanstvenih radova i publikacija Nikole pl. Cindre

U radu autora Basraka, Čaplara i Paara (15) najpotpunija je znanstvena bibliografija (139 bibliografskih jedinica) Nikole Cindre. Ovdje će se ukratko komentirati kako je tekao Cindrin znanstveni i životni put, a referencije koje se navode odnose se upravo na rad tih autora.

Iz životopisa i znanstvene bibliografije Nikole pl. Cindre vidimo da su njegov znanstveni interes i njegova najveća postignuća ostvarena u području nuklearne fizike. Odmah valja dodati i važnu činjenicu, a to je i motivacija ovog rada, da je uz čisti znanstveni interes, N. Cindro bio

plains deviations from Rutherford's formula for cross sections for elastic scattering by the electric splitting of deuterons is not in agreement with experimental results. In the thesis, an analysis given within the optical model is the first systematic analysis of deuteron elastic scattering. The general conclusion is that the optical model of nuclear reactions is also a reliable model for deuteron scattering.

2.1) Review of some scientific and other publications by Nikola Cindro

The work written by Basrak, Čaplar, and Paar (15) is the most complete N. Cindro's bibliography (with 139 entries). Here we will comment on the journey through his scientific life and how this was reflected in his publications. Cited references will be taken from the ref. 15.

From his curriculum vitae and his scientific bibliography, one can see that N. Cindro's interest and most achievements belong to the field of nuclear physics. However we have to add an important fact before we go on that apart from the purely scientific interest he was susceptible to all aspects of science with an emphasis on educational aspects as well as the popularization of science, especially (nuclear) physics. This becomes clear by looking at his opera (given before) where in addition to a large number of scientific publications (15) one can see many contributions written for the journal *Matematičko fizički list* and for *Priroda*. Also one can see publications concerning the social aspects of science and scientific research. Certainly, his great success is two university textbooks that were published in more editions and which were highly rated by university professors and students. Only those who read this text and who are authors of a university textbook could un-

otvoren svim aspektima znanosti, a posebno edukacijskom i popularizatorskom. To je posve jasno iz pregleda njegovih publikacija danih ranije, u kojima, uz golem broj izvornih znanstvenih radova u najuglednijim svjetskim znanstvenim časopisima (15), vidimo niz tekstova objavljenih u *Matematičko-fizičkom listu* i *Prirodi*, ali i tekstova u kojima se promišlja i društveni aspekt znanosti i znanstvenih istraživanja.

Njegovo veliko postignuće su i dva sveučilišna udžbenika koji su doživjeli niz izdanja i koje su izuzetno cijenili i sveučilišni nastavnici i studenti. Samo oni koji čitaju ovaj tekst, a autori su nekoga udžbenika, znaju koliko napora zahtijeva zaokruženje jednoga visokoškolskog udžbenika u knjigu koja zatim predstavlja pouzdano sredstvo prijenosa znanja od (dobrog) autora do (zainteresiranog) studenta.

Ipak, vratimo se nuklearnoj fizici u kojoj je N. Cindro decenijama boravio i u kojoj je pronašao nove ideje i nova znanja koja ostaju kao naslijeđe generacijama.

Može se kazati da je nuklearna fizika počela glasovitim eksperimentom E. Rutherforda (1871. – 1937.) godine 1911. i njegovih suradnika (H. Geigera i E. Marsdena) koji su pokazali da se atom može opisati „planetarnim modelom", tj. da se sastoji od male nakupine pozitivne tvari u središtu golemoga praznog prostora okružene negativnom sfernom raspodjelom negativnog naboja. Pokus se sastojao od bombardiranja zlata (u tankim listićima) alfa-česticama. Rutherford je s pomoću klasične mehanike i klasične elektrodinaderstand how much energy and devotion are required to write a text and turn it into a university textbook which then becomes a reliable transporter of knowledge from an (expert) author to an (interested) student.

But, let us turn to nuclear physics where N. Cindro had been residing for decades and where he found new ideas and new knowledge which stay there as his legacy to generations.

We can say that nuclear physics started with the famous experiment by E. Rutherford (1871–1937) and his associates (H. Geiger and E. Marsden) in the year 1911. They showed that an atom could be described by a „planetary model" which consists of an amount of positive matter in the middle of a huge empty space which is then surrounded by a negative charge distributed over the sphere. The experiment consisted of a source of alpha particles that targeted golden foils and the number of scattered particles – small sparks on a screen – was counted (by Geiger and Marsden). Rutherford derived his famous formula using classical mechanics and classical electrodynamics. Even today scientists doing calculations for similar scattering processes often refer to this formula. One has to remember that it was the pre-quantum age since quantum mechanics – the theory of microscopic processes was „invented" about one decade later. After the discovery of the proton as the source of the positive charge in the nucleus of the planetary model and after the discovery of the neutron as its neutral partner the whole nucleon family was known. It was evident that these particles within the nucleus keep together some peculiar force, certainly not of electromagnetic origin since it holds together with the same strength protons as well (neutral) neutrons. Therefore, one of

mike izveo čuvenu Rutherfordovu formulu na koju se i danas fizičari pozivaju pri razmatranju sličnih procesa raspršenja. Tu se valja sjetiti da je to bilo predkvantno vrijeme, tj. teorija mikroskopskih procesa – kvantna mehanika „izumljena" je deceniju kasnije. Nakon otkrića protona kao one pozitivne tvari koja čini jezgru „planetarnog modela" i njegovog partnera neutrona, čime je zaokružena obitelj nukleona, postalo je jasno da te čestice u jezgri drži neka druga sila, jača od (odbojne) elektromagnetske, ali i posebna, zato jer jednako jako drži zajedno protone i neutrone (koji, sjetimo se, nisu električki nabijeni). Prema tome, jedan od centralnih problema nuklearne fizike jest razumijevanje nuklearne sile i to traje od slavnih dvadesetih i tridesetih godina dvadesetog stoljeća sve do danas. Odmah sljedeći problem, usko vezan uz prvi, jest razumijevanje strukture jezgre. Tu su se, kao i kod opisa sile, stvarali različiti modeli jezgre (optički model, model ljuski itd.) i tu je N. Cindro dao važan doprinos (**slika 4**).

Načini raspršenja bili su, kao i danas, najvažniji izvor podataka o procesima i strukturama. To je vidljivo i iz početka drugoga znanstvenog rada (**slika 5**), koji je zapravo djelomični sadržaj Cindrine doktorske disertacije.

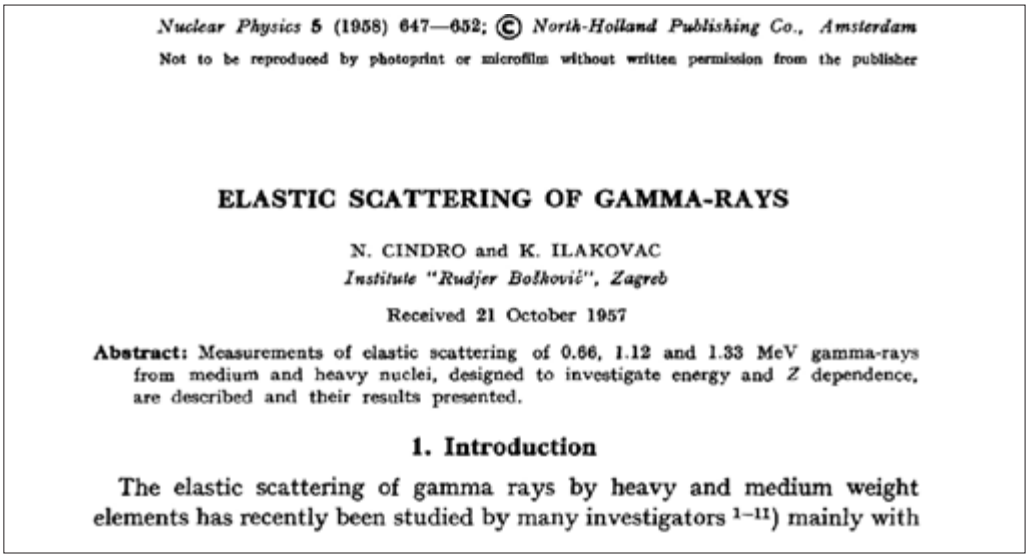
Uz jaku nuklearnu silu koja drži nukleone u jezgri te već od ranije poznate elektromagnetske sile, danas znamo da postoji i treća mikroskopska sila – slaba (nuklearna) sila koja ima važnu ulogu u mikroskopskim procesima (elementarnih čestica i jezgre). Četvrta osnovna sila u prirodi, gravitacijska sila, ostaje za sada

the central problems of nuclear physics was (and still is) understanding this mysterious force. These efforts last until today, from the glorious days of the twentieth century. The next important problem, closely connected to the first one, is understanding the structure of the nucleus. As in the case of the nuclear force for the nuclear structure have been constructed different models (optical model, shell model, etc.) and here N. Cindro gave important contributions (**Figure 4**).

Scattering processes were, as they are today, the most important source of data about processes and structures within nuclei. This could be seen from the introduction of the second scientific paper by N. Cindro and N. S. Wall which is reproduced in **Figure 5**. This paper is in fact the main content of N. Cindro's doctoral dissertation.

Apart from the (strong) nuclear force which holds the nucleons together and from the electromagnetic force known for a long time, we know today that there is another, third microscopic force – weak (nuclear) force which plays a very important role in the microscopic processes (of elementary particles and in the nucleus). The fourth fundamental force in nature is the gravitational force which is somewhat remote from the unified model of the first three fundamental forces in the model called the Standard model.

The serious research in nuclear physics, which stems from experiments „a la Rutherford" and from the theory of microscopic processes – quantum mechanics, produced a research topic that established itself as an independent research field – elementary particle physics. This common origin can be seen in many books that have titles like „Nuclear Physics and Physics of Elementary Particles". For years people doing research in nuclear



Nuclear Physics **5** (1958) 647—652; © *North-Holland Publishing Co., Amsterdam*

ELASTIC SCATTERING OF GAMMA-RAYS

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Received 21 October 1957

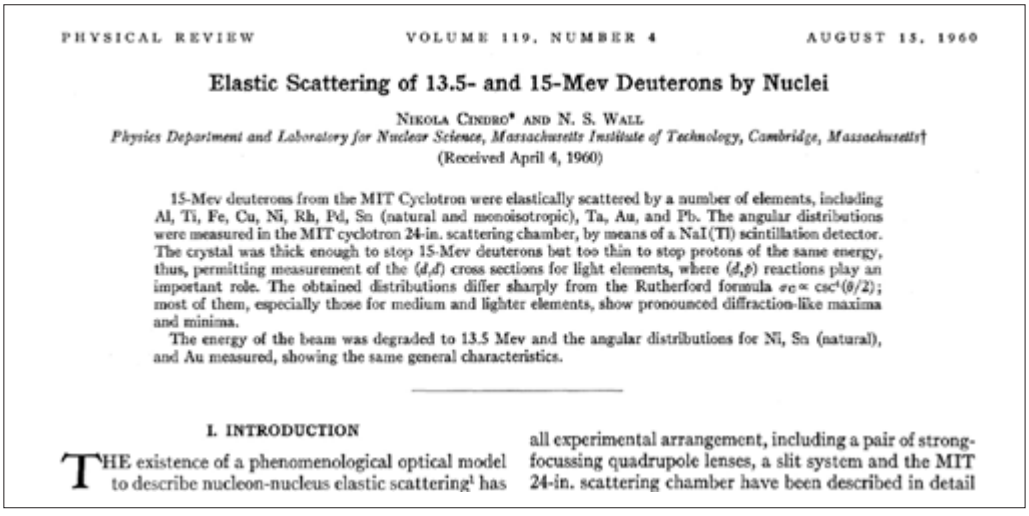
Abstract: Measurements of elastic scattering of 0.66, 1.12 and 1.33 MeV gamma-rays from medium and heavy nuclei, designed to investigate energy and Z dependence, are described and their results presented.

1. Introduction

The elastic scattering of gamma rays by heavy and medium weight elements has recently been studied by many investigators [1–11]) mainly with

SLIKA 4. **Naslovna stranica prvoga znanstvenog rada Nikole Cindre i Ksenofonta Ilakovca, ref. [1] iz (15)**

FIGURE 4. ***The title page of the article was written with Ksenofont Ilakovac as the first scientific paper by Nikola Cindro, a ref. [1] from (15)***



PHYSICAL REVIEW VOLUME 119, NUMBER 4 AUGUST 15, 1960

Elastic Scattering of 13.5- and 15-Mev Deuterons by Nuclei

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(Received April 4, 1960)

15-Mev deuterons from the MIT Cyclotron were elastically scattered by a number of elements, including Al, Ti, Fe, Cu, Ni, Rh, Pd, Sn (natural and monoisotropic), Ta, Au, and Pb. The angular distributions were measured in the MIT cyclotron 24-in. scattering chamber, by means of a NaI(Tl) scintillation detector. The crystal was thick enough to stop 15-Mev deuterons but too thin to stop protons of the same energy, thus, permitting measurement of the (d,d) cross sections for light elements, where (d,p) reactions play an important role. The obtained distributions differ sharply from the Rutherford formula $\sigma_C \propto \csc^4(\theta/2)$; most of them, especially those for medium and lighter elements, show pronounced diffraction-like maxima and minima.

The energy of the beam was degraded to 13.5 Mev and the angular distributions for Ni, Sn (natural), and Au measured, showing the same general characteristics.

I. INTRODUCTION

THE existence of a phenomenological optical model to describe nucleon-nucleus elastic scattering[1] has all experimental arrangement, including a pair of strong-focussing quadrupole lenses, a slit system and the MIT 24-in. scattering chamber have been described in detail

SLIKA 5. **Naslovna stranica rada koji prikazuje djelomični sadržaj doktorske disertacije N. Cindre, ref. [3] iz (15)**

FIGURE 5. ***The title page of the paper, in fact, represents the partial content of N. Cindro's doctoral dissertation, ref. [3] from (15)***

nekako odvojena od ujedinjene teorije sila u modelu zvanom Standardni model.

Nuklearna fizika čije je pravo istraživanje izniklo iz eksperimenata *„a la Rutherford"* i iz teorije mikroskopskih procesa – kvantne mehanike, bila je odskočna daska za danas posve samostalan smjer istraživanja – za fiziku elementarnih čestica. To zajedničko ishodište vidi se u nizu naslova knjiga (malo starijih izdanja) koje nose naslove poput *Nuklearna fizika i fizika elementarnih čestica*. Ono što je dovelo do ponovnog „spajanja" nuklearne fizike i fizike elementarnih čestica je otkriće kvantne kromodinamike – QCD. To je teorija jakog međudjelovanja, teorija jake nuklearne sile koja na metodama kvantne teorije polja objašnjava jako međudjelovanje kvarkova – čestica od kojih je „složen" proton i neutron. Današnji trenutak nuklearne fizike i fizike elementarnih čestica ima niz važnih dodirnih točaka u kojima se metode jedne pretaču u metode druge i obrnuto. Tu valja istaknuti primjerice tzv. kiralnu perturbacijsku teoriju poniklu u česticama a primijenjenu u jezgri. Svakako, zanimljiva je i hipernuklearna fizika u kojoj je u jezgri jedan nukleon zamijenjen elementarnom česticom zvanom hiperon, elementarna čestica koja (najčešće) ima kvark koji se normalno ne nalazi u jezgri. Niz procesa kojima se istražuju ta područja povezana su s teškim ionima, što je tema koja je i Nikolu Cindru zaokupila krajem 1970-ih godina.

Ovdje je ipak dobro sjetiti se velikoga talijanskog fizičara Enrica Fermija (1901. – 1954.), za kojeg se danas kaže da je bio „čovjek koji je sve znao" (a tako glasi i nje-

physics and in particle physics could not see too many connections between these two research areas. But the situation changed after the discovery of quantum chromodynamics (QCD). QCD is the theory of strong interaction between quarks, the theory of the strong force which is based on the quantum field theory and explains the interaction between quarks which are building stones of nucleons. The force is mediated by gluons. Today, nuclear physics and elementary particle physics have many common points at which methods of the first are used by the second and vice versa. It could be mentioned the chiral perturbation theory which stems from particle physics and enters nuclear physics, or hypernuclear physics which is the basic physics of particles containing quarks that are not present in a nucleus, and such a particle replaces one nucleon with remarkable global properties. The problems of the interaction of nuclei and heavy ions certainly belong to the common points and precisely this part of (nuclear) research became part of N. Cindro's interest in the late seventies.

It is interesting to recall the great Italian physicist Enrico Fermi (1901–1954) for whom today people use to say that he was „the man who knew everything" (and these words are part of the title of his biography). Translating those words to physics one arrives at the notion of the physicist who possessed expertise in experimental physics, in constructing experimental facilities (like the first nuclear reactor in 1942 in Chicago), but at the same time who was able to interpret and understand experimental results using the most sophisticated physical theories. Such a man united the „two cultures". Also, E. Fermi is well-known as the author of a series of textbooks in theoretical phys-

gova biografija). U prijevodu na fiziku, to se može objasniti tako da je riječ o fizičaru koji je jednako dobro znao graditi eksperimentalne uređaje (pa i prvi nuklearni reaktor godine 1942. u Chicagu) kao i opisati ih najpreciznijom teorijom. Riječ je, dakle, o čovjeku koji je u sebi ujedinio „dvije kulture", a uz to bio je poznat po nizu tekstova iz teorijske fizike koji i dalje predstavljaju prava remek-djela nastavne literature iz fizike.

Nikola Cindro bio je sigurno eksperimentalni fizičar iz područja nuklearne fizike. Ali, iz njegova znanstvenog opusa vidljiv je niz revijalnih članaka (u eminentnim časopisima) poput *Review of Modern Physics,* ref. [22] iz (15); *Rivista del nuovo cimento* ([34], [61]), *Nukleonika* ([41]), *Ann. Phys. Fr*. ([82]) itd. koji pokazuju da N. Cindro nije bio samo ekspert u „slaganju" eksperimenata i mjerenja već je razumio i duboku teorijsku pozadinu problema, što nas upravo i podsjeća na sintagmu „čovjek koji je sve znao".

Već je ranije spomenuto buđenje Cindrina interesa za procese raspršenja teških iona. Taj je zaokret vidljiv iz njegove znanstvene bibliografije (15), gdje se javlja rad godine 1976., a zatim sve češće prema 1980-ima. Fizika teških iona dominira ostatkom njegove znanstvene karijere. U okviru tih istraživanja došao je do nekih spoznaja koja sam navodi kao vrhunac svojega znanstvenog rada, a riječ je o nuklearnim molekulama koje nastaju pri procesima raspršenja. Tu je i početak stvaranja grupe uglednih fizičara iz Hrvatske (Institut *Ruđer Bošković*, Sveučilište u Zagrebu, Sveučilište u Splitu) koji su se uz ics which even today represent the highest standards in physics.

N. Cindro was certainly an experimental physicist from the experimental nuclear physics research but among his scientific publications, one can see the number of publications of the review type in the most eminent review journals like *Review of Modern Physics,* ref. [22] in (15), *Rivista del nuovo cimento*, ref. [34], [61], *Nukleonika* [41], *Ann. Phys. Fr.* [82] it is evident that apart from the experimental skills he understood the theoretical background of the problems and these facts certainly remind us of the syntagma „the man who knew everything".

We have already mentioned N. Cindro's interest in processes with heavy ion scattering. This turning point in his experimental work is first seen around 1976, and more often in later years towards the eighties. The physics of heavy ions will dominate the rest of his scientific career. Within this research, he arrived at some results which he himself called the peaks of his contribution to (nuclear) physics. The heavy ion scattering showed some results which he interpreted as the existence of certain nuclear molecules present in many nuclei. Here one can trace also the beginning of the formation of the group of physicists from Croatia (IRB, University of Zagreb, University of Split, **Figure 6**). These physicists acquired international recognition and careers. Here we will omit their names but which could be found in ref. (15), from 1976 on.

This interest in the transfer of knowledge N. Cindro best realized in his university textbooks *Fizika 1* and *Fizika 2*. These textbooks were for a long time the best reference books for teachers and students in technical universities in Zagreb

Cindrinu pomoć afirmirali u svjetskim razmjerima. Ovdje izostavljamo njihova imena ali upućujemo na referencije iz (15) od godine 1976. pa nadalje.

Iz ranije opisane biografije vidimo da je kod N. Cindre cijelo vrijeme postojao interes približavanja komplicirane fizike mikrosvijeta mlađim naraštajima, pa možemo slijediti niz članaka u *Matematičko-fizičkom listu* (**slika 6**) i u *Prirodi*.

Taj je interes za prenošenje znanja N. Cindro najbolje realizirao u svojim sveučilišnim udžbenicima (**slika** 7) koji su bili nezaobilazni izvori znanja iz fizike generacijama studenata tehničkih fakulteta u Zagrebu i Splitu. U tom je kontekstu zanimljiva suradnja N. Cindre i Waltera Greinera, primjerice ref. [64] iz (15), poznatog autora niza udžbenika iz moderne fizike (kvantne mehanike, specijalne relativnosti, nuklearne fizike, kvantne teorije polja itd.).

Epilog

Ovim prikazom rada N. Cindre sigurno nije iscrpljen cijeli njegov doprinos hr-

and Split (**Figure** 7). It is interesting here to note that N. Cindro has some publications with Walter Greiner, a ref. [64] in (15), a German physicist who is well-known as the author of a list of university textbooks on modern physics topics like quantum mechanics, special relativity, nuclear physics, quantum field theory, etc.

Epilogue

These pages certainly do not exhaust the presentation of N. Cindro's contributions to Croatian physics but we believe that the text showed that he was a versatile man, a physicist „who knew everything" and who was always prepared to share his expertise and broad knowledge with those who feel the same urge which carried N. Cindro in the world, but which brought him back to his country, to his family and to his people.

3) Other publications and activities by Nikola Cindro

In chapter 2.1) it has already been pointed out that so far the most complete list of Cindro's scientific publications was published by Zoran Basrak,

Zakoni očuvanja u fizici

Dr NIKOLA CINDRO, Zagreb — Pariz

U jednom skorašnjem članku u »Matematičko-fizičkom listu«, (Mat. fiz. list br. 2, Tom XIV) prikazani su zakoni očuvanja fizičkih veličina koji vrijede u svijetu elementarnih čestica. Cilj nam je da ove zakone prikažemo sa jednog drugog aspekta, tj. da prikažemo kontinuitet tih zakona, koji svoje porijeklo vode iz klasične fizike makroskopskog svijeta. Da bismo pokazali kako se fizika i dalje razvija, u drugom dijelu članka prikazat ćemo neke nove zakone očuvanja, koji su pronađeni isključivo zahvaljujući eksperimentima u visokoenergetskoj fizici.

SLIKA 6. **Početak Cindrina rada iz *Matematičko-fizičkog lista* o jednom izuzetno važnom zakonu u fizici**

*FIGURE 6. **Opening sentences of an article about a very important physical principle in the journal*** **Matematičko fizički list***, **the journal for high school students***

vatskoj fizici, ali je, vjerujemo, pokazao da je N. Cindro bio svestran čovjek, fizičar „koji je sve znao" i koji je uvijek bio spreman to svoje bogato znanje podijeliti s onima koji osjećaju isti poriv koji je i njega samoga odveo tako daleko u svijet, ali ga je i vratio njegovoj domovini, njegovoj obitelji i njegovom narodu.

Roman Čaplar and Vladimir Paar; 139 bibliographic units are listed. (15) We add a list of Cindro's other publications: editorial activity, councils and committees – 12 responsibilities (2, 8).

The following is a new list of works in journals and proceedings – 58 bibliographic units (further: b. j.), in the journal *Matematičko-fizički list* – 9 b.

SLIKA 7. **Naslovne stranice sveučilišnih udžbenika (*Fizika 1* i *Fizika 2*) N. Cindre; ti su udžbenici godinama bili izvor znanja iz klasične fizike**

FIGURE 7. ***Title pages of university textbooks (*Fizika 1** and **Fizika 2**) by N. Cindro; these textbooks have been a source of knowledge in classical physics for years***

3. Ostale publikacije i aktivnosti Nikole Cindre

U poglavlju 2.1. već je istaknuto da su dosad najpotpuniji popis Cindrinih znanstvenih publikacija (radova) objavili Zoran Basrak, Roman Čaplar i Vladimir Paar. Navedeno je 139 bibliografskih jedinica. (15) Tome pridodajemo popis ostalih Cindrinih publicističkih aktivnosti: uređivačka djelatnost, savjeti i odbori – 12 zaduženja (2, 8).

j. (16) and *Priroda* – 7 b. j. (17), in other magazines – 3 b. j., then books and newsletters – 7 b. j., chapters in books and proceedings and progress reports – 5 b. j. and one book translation as one bibliographic unit.

3.1) Editing (editor, coeditor, member of the publication board)

1. *Nuclear Structure and Nuclear Reactions*, Proceedings of Ninth Summer Meeting of Nuclear Physicists, Herceg Novi, 1964.

Slijedi novi popis radova u časopisima i zbornicima radova – 58 bibliografskih jedinica (dalje: b.j.), u časopisu *Matematičko-fizički list* – 9 b. j. (16) i *Prirodi* – 7 b. j. (17), u ostalim časopisima – 3 b. j., zatim knjige i bilteni – 7 b. j., poglavlja u knjigama i zbornicima radova – 5 b. j. i jedan prijevod knjige kao jedna bibliografska jedinica.

3.1. Uređivačka djelatnost (urednik ili suurednik, član izdavačkog savjeta i član uredničkoga odbora)

1. *Nuclear Structure and Nuclear Reactions*, Proceedings of Ninth Summer Meeting of Nuclear Physicists, Herceg Novi, 1964.
2. *Proceedings of the Europhysics Study Conference on Intermediate Processes in Nuclear Reactions,* Plitvice, 1972, Berlin-Heidelberg, 1973. zajedno s P. Kulišićem i T. Mayer-Kuckukom.
3. *Nuclear Molekular Phenomena,* Hvar, 1977.
4. *Dynamics of Heavy Ion Collisions*, Amsterdam 1981.
5. *Fundamental Problem in Heavy Ion Reactions,* Singapore, 1984. zajedno s W. Greinerom i R. Čaplarom.
6. *Frontiers of Heavy Ion Physics,* Singapore, 1987. zajedno s W. Greinerom i R. Čaplarom.
7. *Proceedings of the 174. Weheraeus* – Seminar: *NEW IDEAS on Clustering in Nuclear and Atomic Physics,* Njemačka, 1997. zajedno s W. Scheidom.
8. *Scientists against the War in Croatia*, Zagreb, 1992.

Su-urednik urednik časopisa

1. *Heavy Ion Physics*

Član međunarodnoga izdavačkog savjeta časopisa

1. *Acta Physica Slovaca*
2. *Europhysics Letters*, do 1987.
2. *Proceedings of the Europhysics Study Conference on Intermediate Processes in Nuclear Reactions,* Plitvice, 1972, Berlin-Heidelberg, 1973. together with P. Kulišić and T. Mayer-Kuckuk.
3. *Nuclear Molecular Phenomena,* Hvar, 1977.
4. *Dynamics of Heavy Ion Collisions*, Amsterdam 1981.
5. *Fundamental Problem in Heavy Ion Reactions,* Singapore, 1984. together with W. Greiner and i R. Čaplar.
6. *Frontiers of Heavy Ion Physics,* Singapore, 1987. together with W. Greiner and R. Čaplar.
7. *Proceedings of the 174. Weheraeus* – Seminar: *NEW IDEAS on Clustering in Nuclear and Atomic Physics,* Germany, 1997. together with W. Scheid.
8. *Scientists against the War in Croatia*, Zagreb, 1992.

Coeditor of the journal

1. *Heavy Ion Physics*

Member of the international publishing board for the journals

1. *Acta Physica Slovaca*
2. *Europhysics Letters*, to 1987.

Member of the editorial board

1. *Scientific Research in Croatia*, MZT, Zagreb, 1995.

3.2) Publications in other journals, proceedings and books of abstracts

1. N. Cindro and P. Klein: *Alpha-d Reactions on B^{10} and N^{14}*, Progress Report, Mass. Inst. of Technology (LNS) (1957/1958) 149–150.
2. P. Klein and N. Cindro: *A Time – of – flight Apparatus for fast Neutrons*, Progress Report, Mass. Inst. of Technology (LNS) (1958) 144–145.
3. M. A. Mekannof and N. Cindro: *Analysis of Elastic Scattering of Deuterons with Optical Model*, Proc. of the Tallahassee Conf. On the *Nuclear Optical Model*, 1958, pp. 272–286.

Član uredničkog odbora časopisa

1. *Scientific Research in Croatia*, MZT, Zagreb, 1995.

3.2. Radovi u časopisima i zbornicima radova

1. N. Cindro and P. Klein: *Alpha-d Reactions on B^{10} and N^{14}*, Progress Report, Mass. Inst. of Technology (LNS) (1957/1958) 149–150.
2. P. Klein and N. Cindro: *A Time – of – flight Apparatus for fast Neutrons*, Progress Report, Mass. Inst. of Technology (LNS) (1958) 144–145.
3. M. A. Mekannof and N. Cindro: *Analysis of Elastic Scattering of Deuterons with Optical Model*, Proc. of the Tallahassee Conf. On the *Nuclear Optical Model*, 1958, pp. 272–286.
4. N. Cindro: *A Method of Charged Particle Selection*, Glas. Matem.-fiz. i astron. **15** (1960) 113–118.
5. L. W. Swenson and N. Cindro: *Energy and Angular Distributions of Protons* from *(α, p) Reactions*, Bull. Am. Phys. Soc. **5** (1960) 76–77.
6. N. Cindro: *Total reaction cross sections measurement and analysis*, Proc. V meeting of nuclear physicists, Vol. II, Herceg Novi, 1962.
7. P. Kulišić, P. Strohal, Z. Kolar and N. Cindro: *Statistical fluctuations in the total reaction cross sections*, CR Concr. Int. Physique nucleaire **2** (1964) 678–680.
8. B. Lalović, V. Ajdačić, P. Strohal, P. Kulišić, D. Kovač and N. Cindro: *(n, α) reactions on some heavy nuclei*, CR Congres Internal Physique Nucléaire **2** (1964) 769–771.
9. J. Vuletin and N. Cindro: *Cross sections for some (n, 2n) reactions*, Glasnik mat.-fiz. i astron. **19** (1964) 269–273.
10. G. Adam, G. Bassani, N. Cindro, C. Levi, M. Mermaz and L. Papineau: *Analog states in lead isotopes. Isobaric spin in nuclear physics*, Academic Press, 1966, pp. 366–372.
11. R. Ballini, J. Delaunay, J. P. Fouan, A. G. Blair and N. Cindro: *Single particle-hole and collective levels*, Izvjestja A. N. SSSR, Ser Fizičeskaja **32** (1968) 1653.
12. M. L. Chatterjee, N. Cindro, M. Jurčević, P. Kulišić and J. Tudorić: *Single neutron states in* (n, *α) cluster transfer reactions*, Proc. Int. Conf. on *Clustering phenomena in Nuclei*, IAEA, Vienna, 1969, pp. 210–211.
13. N. Cindro: *Basic evidence and properties of single-particle levels*, In: *Theory of nuclear structures*, IAEA, Vienna, 1970, pp. 195–226.
14. N. Cindro: *Nuclear reaction mechanisms: a critical description*, Proc. Int. School of Nuclear Physics (A. Corciovei, ed.), Predeal, Rumania, 1970, pp. 77–150.

ctive levels, Izvjestja A. N. SSSR, Ser Fizičeskaja **32** (1968) 1653.

12. M. L. Chatterjee, N. Cindro, M. Jurčević, P. Kulišić and J. Tudorić: *Single neutron states in* (n, *α) cluster transfer reactions*, Proc. Int. Conf. on *Clustering phenomena in Nuclei*, IAEA, Vienna, 1969, pp. 210–211.
13. N. Cindro: *Basic evidence and properties of single-particle levels*, In: *Theory of nuclear structures*, IAEA, Vienna, 1970, pp. 195–226.
14. N. Cindro: *Nuclear reaction mechanisms: a critical description*, Proc. Int. School of Nuclear Physics (A. Corciovei, ed.), Predeal, Rumania, 1970, pp. 77–150.
15. N. Cindro: *The calcium region*, In: *The structure of f 7/2 nuclei* (R. Ricci, ed.), Padova, 1971, pp. 63–77.
16. N. Cindro: *Selected topics in nuclear reaction mechanisms*, Proc. 4th Summer School of Nucl. Phys. Rudziska, Poland, Vol. II, 1971, pp. 73–182.
17. N. Cindro: *Optical model studies*, In: *Nuclear Structure Study with Neutrons* (G. Ero and J. Szucz, eds.), Budapest, 1974, pp. 381–405.
18. N. Cindro: *Selected topics in nuclear structure investigation with fast neutrons*, Proc. 2nd Int. Conf. on *Neutron Physics*, Alushta, SSSR, Comm. JINR – Dubna, SSSR, D-37991, 1974, pp. 358–402.
19. N. Cindro: *Narrow structure in the continuum observed in heavy ion reactions*, Proc. In. School of Physics „Enrico Fermi", Varenna, Italy, *Nuclear Spectroscopy and Nuclear Reactions with Heavy lons* (H. Faraggi and R. Ricci, eds.), 1976, pp. 271–351.
20. N. Cindro and J. Frehaut: *Current problems in (n, 2n) reactions*, Proc. Int. Symp. on *Fast Neutrons* (D. Seeliger, ed.), ZIK, Dresden, (324) (1976) 6–23.
21. E. Holub, N. Cindro, O. Bersillon and J. Jary: *Investigation of the (n, 2n) reaction by the statistical model*, Proc. Int. Conf. on *Fast Neutrons* (D. Seeliger, ed.), ZIK, Dresden, (324) (1976) 87–93.
15. N. Cindro: *The calcium region*, In: *The structure of f 7/2 nuclei* (R. Ricci, ed.), Padova, 1971, pp. 63–77.
16. N. Cindro: *Selected topics in nuclear reaction mechanisms*, Proc. 4th Summer School of Nucl. Phys. Rudziska, Poland, Vol. II, 1971, pp. 73–182.
17. N. Cindro: *Optical model studies*, In: *Nuclear Structure Study with Neutrons* (G. Ero and J. Szucz, eds.), Budapest, 1974, pp. 381–405.
18. N. Cindro: *Selected topics in nuclear structure investigation with fast neutrons*, Proc. 2nd Int. Conf. on *Neutron Physics*, Alushta, SSSR, Comm. JINR – Dubna, SSSR, D-37991, 1974, pp. 358–402.
19. N. Cindro: *Narrow structure in the continuum observed in heavy ion reactions*, Proc. In. School of Physics „Enrico Fermi", Varenna, Italy, *Nuclear Spectroscopy and Nuclear Reactions with Heavy lons* (H. Faraggi and R. Ricci, eds.), 1976, pp. 271–351.
20. N. Cindro and J. Frehaut: *Current problems in (n, 2n) reactions*, Proc. Int. Symp. on *Fast Neutrons* (D. Seeliger, ed.), ZIK, Dresden, (324) (1976) 6–23.
21. E. Holub, N. Cindro, O. Bersillon and J. Jary: *Investigation of the (n, 2n) reaction by the statistical model*, Proc. Int. Conf. on *Fast Neutrons* (D. Seeliger, ed.), ZIK, Dresden, (324) (1976) 87–93.
22. N. Cindro: *Neutron induced reactions II (n, x) reactions on medium and heavy* nuclei, Proc. Int. Conf. on the *Interaction of Neutrons with Nuclei*, Lowell, USA, 1976, ERDA – CONF-76071-P1, 1976, pp. 347–364.
23. N. Cindro: *Resonances in Heavy Ion Reactions – New Aspects*, In: *Selected Topics in Nuclear Structure* (Z. Stachura and J. Styczen, eds.), Krakow, Report No 963/PL, 1977, pp. 69–106.
24. N. Cindro and E. Holub: *Selected topics in nuclear reaction investigations with fast neutrons*, Proc. 3rd Int. *School of Neutron Physics*, Alushta, USSR,

22. N. Cindro: *Neutron induced reactions II (n, x) reactions on medium and heavy* nuclei, Proc. Int. Conf. on the *Interaction of Neutrons with Nuclei*, Lowell, USA, 1976, ERDA – CONF-76071-P1, 1976, pp. 347–364.
23. N. Cindro: *Resonances in Heavy Ion Reactions – New Aspects*, In: *Selected Topics in Nuclear Structure* (Z. Stachura and J. Styczen, eds.), Krakow, Report No 963/PL, 1977, pp. 69–106.
24. N. Cindro and E. Holub: *Selected topics in nuclear reaction investigations with fast neutrons*, Proc. 3rd Int. *School of Neutron Physics*, Alushta, USSR, JINR Dubna Rep. D3-11787, 1978, pp. 458–485.
25. D. Počanić and N. Cindro: *Comparison of schematic model predictions of resonance*s, In: *Dynamics of Heavy Ion Collisions*, Proc. 4th Internat. Adriatic Meeting on Nuclear Physics (N. Cindro, R. Ricci and W. Greiner, eds.) North Holland, Amsterdam, 1981, pp.101–114.
26. E. Holub and N. Cindro: *The Reaction Mechanism of the (n, 2n) Reaction*, Proceedings of the Second International Symposium, Smolenice, June 25–29, 1979.
27. N. Cindro and D. Počanić: *Schematic models of resonances: predictions and comparison Int. Workshop in Resonances in Heavy-Ion Reactions*, Bad Hommaf., 2–15 October, 1989.
28. D. Počanić and N. Cindro: *An orbiting – cluster description of resonances in heavy-ion reactions*; *Nuclear Structure and Heavy-Ion Collisions*, LXXCII Corso Varena, 1981, pp. 699–703.
29. M. Korolija, E. Holub, N. Cindro and D. Hilscher: *Light-ion preequilibrium models and the emissions of nucleons from reactions induced by medium energy heavy-ions*, Proc. Int. Conf. on *Nuclear Physics*, Florence, 29. VIII–3. IX 1983.
30. N. Cindro, F. Haas, D. Freeman: *Experimental discovery of the Landau-Zener effect in atomic nuclei,* Lecture *Notes in Physics*, Springer-Verlag (211) (1984) 204–216.
JINR Dubna Rep. D3-11787, 1978, pp. 458–485.
25. D. Počanić and N. Cindro: *Comparison of schematic model predictions of resonance*s, In: *Dynamics of Heavy Ion Collisions*, Proc. 4th Internat. Adriatic Meeting on Nuclear Physics (N. Cindro, R. Ricci and W. Greiner, eds.) North Holland, Amsterdam, 1981, pp.101–114.
26. E. Holub and N. Cindro: *The Reaction Mechanism of the (n, 2n) Reaction*, Proceedings of the Second International Symposium, Smolenice, June 25–29, 1979.
27. N. Cindro and D. Počanić: *Schematic models of resonances: predictions and comparison Int. Workshop in Resonances in Heavy-Ion Reactions*, Bad Hommaf., 2–15 October, 1989.
28. D. Počanić and N. Cindro: *An orbiting – cluster description of resonances in heavy-ion reactions*; *Nuclear Structure and Heavy-Ion Collisions*, LXXCII Corso Varena, 1981, pp. 699–703.
29. M. Korolija, E. Holub, N. Cindro and D. Hilscher: *Light-ion preequilibrium models and the emissions of nucleons from reactions induced by medium energy heavy-ions*, Proc. Int. Conf. on *Nuclear Physics*, Florence, 29. VIII–3. IX 1983.
30. N. Cindro, F. Haas, D. Freeman: *Experimental discovery of the Landau-Zener effect in atomic nuclei,* Lecture *Notes in Physics*, Springer-Verlag (211) (1984) 204–216.
31. N. Cindro and D. Počanić: *Resonances in heavy-ion reactions – structural* vs. *diffractional models*, Lecture *Notes in Physics*, Springer-Verlag (211) (1984) 158–181.
32. N. Cindro, M. Korolija and E. Holub: *Counting the number of degrees of freedom in a hot nucleus-nucleus system from the preequilibrium emission of nucleons*, Proc. of the Workshop on *Coincident Particle Emission from Continuum States in Nuclei* (H. Machner and P. Jahn, eds.), World Scientific Publ., Singapore,1984, pp. 377–390.

31. N. Cindro and D. Počanić: *Resonances in heavy-ion reactions – structural* vs. *diffractional models*, Lecture *Notes in Physics*, Springer-Verlag (211) (1984) 158–181.
32. N. Cindro, M. Korolija and E. Holub: *Counting the number of degrees of freedom in a hot nucleus-nucleus system from the preequilibrium emission of nucleons*, Proc. of the Workshop on *Coincident Particle Emission from Continuum States in Nuclei* (H. Machner and P. Jahn, eds.), World Scientific Publ., Singapore,1984, pp. 377–390.
33. R. Freeman, C. Beck, F. Haas and N. Cindro: *Experimental evidence for the nuclear Landau-Zener effect*, In: *Fundamental Problems in Heavy-Ion Collisions*, Proc 5th Adriatic Internat. Conf. on *Nuclear Physics*, Hvar, Yugoslavia (N. Cindro, W. Greiner and R. Čaplar, eds.), World Scientific Publ. Co., Singapore, 1994, pp. 77–85.
34. N. Cindro, M. Korolija and E. Holub: *Preequilibrium emission of nucleons in heavy-ion collisions; counting the initial number of degrees of freedom in a nucleus-nucleus collision*, In: *Fundamental Problems in Heavy-Ion Collisions*, Proc.5th Adriatic Internat. Conf. on *Nuclear Physics*, Hvar, Yugoslavia (N. Cindro, W. Greiner and R. Čaplar, eds.), World Scientific Publ. Co., Singapore, 1984, pp. 301–312.
35. M. Korolija, R. Auble, N. Cindro and R. Čaplar: *Proton emission from the symmetric 58Ni+ 58Ni collision and the diabatic dissipation model*, Proceedings International *Nuclear Physics* Conference, Harrogate, 25–30 August, 1986, Vol. 1.
36. N. Cindro, R. Freeman, F. Haas and C. Beck: *The Landau-Zener effect in nuclear physics,* In: *Proc. Internat. Conf. on Neclear Structure with Heavy-Ions*, Legnaro, Italy (R. A. Ricci and C. Vili, eds.), Soc. Italiana di Fisica, Bologna, Italia, 1986, 489–500.
37. M. Korolija, R. Čaplar and N. Cindro: *Multisource analysis of inclusive proton spectra from collisions of the 678.8 MeV 32S projectile with various targets*, Proc. XVIth Internat. Symp. on *Nuclear Physics, Dynamics of Heavy-Ion Collisions*, Gaussig, November 10–14, 1986.
38. R. Čaplar, M. Korolija and N. Cindro: *Thermodynamic description of preequilibrium emission of nucleons in nucleus-nucleus collisions*, Proceedings of a Specialists Meeting on *Preequilibrium Nuclear Reactions,* Semmering, Austria, 10–12 February, 1988.
39. N. Cindro, M. Korolija and R. Čaplar: *Thermodynamics of nuclear systems prior to equilibrium; in-*

on *Nuclear Physics, Dynamics of Heavy-Ion Collisions*, Gaussig, November 10–14, 1986.

38. R. Čaplar, M. Korolija and N. Cindro: *Thermodynamic description of preequilibrium emission of nucleons in nucleus-nucleus collisions*, Proceedings of a Specialists Meeting on *Preequilibrium Nuclear Reactions,* Semmering, Austria, 10–12 February, 1988.
39. N. Cindro, M. Korolija and R. Čaplar: *Thermodynamics of nuclear systems prior to equilibrium; introducing an exciton – based preequilibrium temperature concept*, Rev. Roum. Phys, Bucarest, **33**(4-6) (1988) 473–479.
40. N. Cindro: *Convening lecture*, In: *Proc. 6th Adriatic Internat. Conf. on Nuclear Physics, Frontiers of Heavy-Ion Physics (*N. Cindro, W. Greiner and R. Čaplar, eds.), World Scientific, Singapore, 1988, pp. 3–15.
41. R. Čaplar, N. Cindro, S. Datta and M. Korolija: *Preequilibrium emission of nucleons and coalescence of complex particles in heavy ion reactions*, In: Proc. 6th Adriatic Internat. Conf. on *Nuclear Physics, Frontiers of Heavy-Ion Physics* (N. Cindro, W. Greiner and R. Čaplar, eds.), World Scientific, Singapore, 1988, pp. 245–259.
42. N. Cindro: *The early stages of nucleus-nucleus collisions and the concept of the preequilibrium temperature parameter*, Proc. of the 5th International Conference on *Nuclear Reaction Mechanisms*, Varena, Italy, June 13–18, 1988, (E. Gadioli, ed.), Ricenca Scientifica ed Educazione Permanente (Suppl. No 66) (1988) 194–201.
43. N. Cindro: *Convening lecture*, In: Proc. 6th Adr. Int. Conf. on *Nucl. Physics, Frontiers of Heavy-Ion Physics* (N. Cindro, W. Greiner and R. Čaplar, eds.), World Scientific, Singapore, 1988, pp. 3–15.
44. N. Cindro and M. Božin: *Resonances, Heavy-Ion Radioactivity and New Predictions in Medium – Mass Colliding Systems*, In: *Heavy-Ions in Nuclear and Atomic Physics* (Z. Wilhelm and G. Szeflinska and A. Hilger, eds.), Bristol, 1989, pp. 239–250.

troducing an exciton – based preequilibrium temperature concept, Rev. Roum. Phys, Bucarest, **33**(4-6) (1988) 473–479.

40. N. Cindro: *Convening lecture*, In: *Proc. 6th Adriatic Internat. Conf. on Nuclear Physics, Frontiers of Heavy-Ion Physics (*N. Cindro, W. Greiner and R. Čaplar, eds.), World Scientific, Singapore, 1988, pp. 3–15.
41. R. Čaplar, N. Cindro, S. Datta and M. Korolija: *Preequilibrium emission of nucleons and coalescence of complex particles in heavy ion reactions*, In: Proc. 6th Adriatic Internat. Conf. on *Nuclear Physics, Frontiers of Heavy-Ion Physics* (N. Cindro, W. Greiner and R. Čaplar, eds.), World Scientific, Singapore, 1988, pp. 245–259.
42. N. Cindro: *The early stages of nucleus-nucleus collisions and the concept of the preequilibrium temperature parameter*, Proc. of the 5th International Conference on *Nuclear Reaction Mechanisms*, Varena, Italy, June 13–18, 1988, (E. Gadioli, ed.), Ricenca Scientifica ed Educazione Permanente (Suppl. No 66) (1988) 194–201.
43. N. Cindro: *Convening lecture*, In: Proc. 6th Adr. Int. Conf. on *Nucl. Physics, Frontiers of Heavy-Ion Physics* (N. Cindro, W. Greiner and R. Čaplar, eds.), World Scientific, Singapore, 1988, pp. 3–15.
44. N. Cindro and M. Božin: *Resonances, Heavy-Ion Radioactivity and New Predictions in Medium – Mass Colliding Systems*, In: *Heavy-Ions in Nuclear and Atomic Physics* (Z. Wilhelm and G. Szeflinska and A. Hilger, eds.), Bristol, 1989, pp. 239–250.

45. N. Cindro: *Recent research in heavy-ion resonances*, In: *Development of Nuclear Cluster Dynamics* (Y. Akaishi, K. Kato, H. Moto and S. Okabe, eds.), World Scientific, Singapore, 1989, pp. 206–217.
46. D. Shapira, J. Gomez del Campo, H. Kim, E. L. Chavez, J. P. Wieleczko, J. Y. Shea, C. F. Maguire, M. Korolija, N. Cindro and K. Teh: *Toward a unified dynamic model for heavy ion reactions – ex-*

45. N. Cindro: *Recent research in heavy-ion resonances*, In: *Development of Nuclear Cluster Dynamics* (Y. Akaishi, K. Kato, H. Moto and S. Okabe, eds.), World Scientific, Singapore, 1989, pp. 206–217.

46. D. Shapira, J. Gomez del Campo, H. Kim, E. L. Chavez, J. P. Wieleczko, J. Y. Shea, C. F. Maguire, M. Korolija, N. Cindro and K. Teh: *Toward a unified dynamic model for heavy ion reactions – exclusive measurements of Br+Al and Ni+Mg at incident energies near 11-12 MeV/amu*, Proc. of the 7th Adriatic Int. Conf. on *Nuclear Physics, Heavy-Ion Physics – Today and Tomorrow*, Islands of Brioni, Croatia, 1991 (R. Čaplar and W. Greiner, eds.), World Scientific, Singapore, 1991, pp. 121–130.

47. M. Korolija, D. Shapira, N. Cindro, J. Gomez del Campo, H. J. Kim, K. Teh and J. Y. Shea: *Interferometric studies from p-p-fragment coincidencess*, Proc. of the 7th Adriatic Int. Conf. on *Nuclear Physics, Heavy-Ion Physics – Today and Tomorrow*, Islands of Brioni, Croatia, 1991 (R. Čaplar and W. Greiner, eds.), World Scientific, Singapore, 1991, pp. 165–174.

48. N. Cindro, E. Betak, J. J. Griffin and M. Korolija: A microscopic model for *calculating the initial exciton number in heavy - ion collisions*, Proc. of the 6th Int. Conf. on *Nuclear Reaction Mechanisms* (E. Gadioli, ed.), Varenna, Italy, Univ. of Milano, Milano (Supp. No. 84) (1991) 63.

49. J. P. Alard, Z. Basrak, N. Bastid, I. M. Belayev, D. Best, M. Bini, Th. Blaich, R. Bock, A. Buta, R. Čaplar, C. Cerruti, N. Cindro, J. P. Coffin, M. Crouau, P. Dupieux, J. Erö. Z. G. Fan, P. Fintz, Z. Fodor, R. Freifelder, L. Fraysse, S. Frollov, A. Gobbi, Y. Grigorian, G. Guillaume, N. Herrmann, K. D. Hildenbrand, S. Hölbling. O. Houari, S. C. Jeong, M. Jorio, F. Jundt, J. Kecskemeti, P. Koncz, Y. Korchagin, R. Kotte, M. Krämer, C. Kuhn, I. Legrand, A. Lebedev, C. Maguire, V. Manko, T. Matulewicz, G. Mgebrishvili, J. Mösner, D. Moisa, G. Montarou, P. Morel, W. Neubert, A. Olmi, G. Pasquali, D. Pelte, C. Pinkenburg, *clusive measurements of Br+Al and Ni+Mg at incident energies near 11-12 MeV/amu*, Proc. of the 7th Adriatic Int. Conf. on *Nuclear Physics, Heavy-Ion Physics – Today and Tomorrow*, Islands of Brioni, Croatia, 1991 (R. Čaplar and W. Greiner, eds.), World Scientific, Singapore, 1991, pp. 121–130.

47. M. Korolija, D. Shapira, N. Cindro, J. Gomez del Campo, H. J. Kim, K. Teh and J. Y. Shea: *Interferometric studies from p-p-fragment coincidencess*, Proc. of the 7th Adriatic Int. Conf. on *Nuclear Physics, Heavy-Ion Physics – Today and Tomorrow*, Islands of Brioni, Croatia, 1991 (R. Čaplar and W. Greiner, eds.), World Scientific, Singapore, 1991, pp. 165–174.

48. N. Cindro, E. Betak, J. J. Griffin and M. Korolija: A microscopic model for *calculating the initial exciton number in heavy - ion collisions*, Proc. of the 6th Int. Conf. on *Nuclear Reaction Mechanisms* (E. Gadioli, ed.), Varenna, Italy, Univ. of Milano, Milano (Supp. No. 84) (1991) 63.

49. J. P. Alard, Z. Basrak, N. Bastid, I. M. Belayev, D. Best, M. Bini, Th. Blaich, R. Bock, A. Buta, R. Čaplar, C. Cerruti, N. Cindro, J. P. Coffin, M. Crouau, P. Dupieux, J. Erö. Z. G. Fan, P. Fintz, Z. Fodor, R. Freifelder, L. Fraysse, S. Frollov, A. Gobbi, Y. Grigorian, G. Guillaume, N. Herrmann, K. D. Hildenbrand, S. Hölbling. O. Houari, S. C. Jeong, M. Jorio, F. Jundt, J. Kecskemeti, P. Koncz, Y. Korchagin, R. Kotte, M. Krämer, C. Kuhn, I. Legrand, A. Lebedev, C. Maguire, V. Manko, T. Matulewicz, G. Mgebrishvili, J. Mösner, D. Moisa, G. Montarou, P. Morel, W. Neubert, A. Olmi, G. Pasquali, D. Pelte, C. Pinkenburg, M. Petrovici, G. Poggi, F. Rami, W. Reisdorf, A. Sadchikov, D. Schüll, Z. Seres, B. Sikora, V. Simion, S. Smolyankin, U. Sodan, N. Taccetti, K. Teh, R. Tezkratt, M. Trzaska, M. A. Vasiliev, P. Wagner, J. P. Wessels, T. Wienold, Z. Wilhelmi, D. Wohlfarth and A. L Zhilin: *Flow and cluster formation in Au on Au collisions at S1S energies*, Proc. of the XXX Win-

M. Petrovici, G. Poggi, F. Rami, W. Reisdorf, A. Sadchikov, D. Schüll, Z. Seres, B. Sikora, V. Simion, S. Smolyankin, U. Sodan, N. Taccetti, K. Teh, R. Tezkratt, M. Trzaska, M. A. Vasiliev, P. Wagner, J. P. Wessels, T. Wienold, Z. Wilhelmi, D. Wohlfarth and A. L Zhilin: *Flow and cluster formation in Au on Au collisions at S1S energies*, Proc. of the XXX Winter Meeting on Nuclear Physics (I. Iori, ed.), Bormio, Italy, Univ. of Milano, Milano (Supp. No. 2) (1992).

50. N. Cindro, M. Korolija and D. Shapira: *Two proton correlations from heavy-ion collisions: determining the reaction zone of Ni+Ni by the Hanbury-Brown-Twiss effect*, Proc. of the Int. *School of Nucl. Physics*, 14th Course, *Heavy Ion Collisions at Intermediate and Relativistic Energies*, Erice, Trapani, Sicily, lely??, 1993, Prog. Part. Nucl. Phys. **30** (1993) 65–73.
51. U. Abbondanno, P. Boccaccio, M. Božin, N. Cindro, F. Demanins, R. A. Ricci, G. Vannini and L. Vanucci: *Search for resonances in the 46Ti+58Ni scattering*, Proc. of the 7th Adriatic International Conference on *Nuclear Physics – Heavy-Ion Physics Today and Tomorrow* (R. Čaplar und W. Greiner, eds.), 1991, pp. 51–52.
52. N. Cindro, U. Abbondanno, W. Greiner, M. Bettiolo, M. Bruno, M. D'Agostino, P. M. Milazzo, R. A. Ricci, G. Vannini and L. Vanucci: *Resonances, superdefumation, high spin*, In: *Nuclear Physics of our Times* (Ramayya, ed.), World Scientific Publ. Co., Singapore, 1993, p. 423.
53. M. Korolija, D. Shapira and N. Cindro: *Exclusive measurement of p-p-fragment coincidences at 15 MeV/u*, Proc. of the Int. Symp. on *Reflections & Directions in Low Energy Heavy-Ion Physics*, JIHIR, Oak Ridge, TN, USA, 1993 (J. H. Hamilton, Chair.), World Scientific, Singapore, 1993, p. 163.
54. A. Gobbi (for the FOPI Collaboration): *Energy deposition in Au on Au collisions*, Proc. of the XX Winter Meeting on *Nuclear Physics* (I. Iori, ed.), Bormio, Italy, Univ. of Milano, Milano (Supp No. 97) (1994) 53–66.
55. S. Hölbling, Z. Basrak, N. Cindro, R. Čaplar and M. Dželalija (for the FOPI Collabora-tion): *Directed sidewards flow in Au+Au collisions at incident* energies *150-800 A MeV*, Proc. of the XXXII Winter Meeting on *Nuclear Physics* (I. Iori, ed.),

ter Meeting on Nuclear Physics (I. Iori, ed.), Bormio, Italy, Univ. of Milano, Milano (Supp. No. 2) (1992).

50. N. Cindro, M. Korolija and D. Shapira: *Two proton correlations from heavy-ion collisions: determining the reaction zone of Ni+Ni by the Hanbury-Brown-Twiss effect*, Proc. of the Int. *School of Nucl. Physics*, 14th Course, *Heavy Ion Collisions at Intermediate and Relativistic Energies*, Erice, Trapani, Sicily, lely, 1993, Prog. Part. Nucl. Phys. **30** (1993) 65–73.
51. U. Abbondanno, P. Boccaccio, M. Božin, N. Cindro, F. Demanins, R. A. Ricci, G. Vannini and L. Vanucci: *Search for resonances in the 46Ti+58Ni scattering*, Proc. of the 7th Adriatic International Conference on *Nuclear Physics – Heavy-Ion Physics Today and Tomorrow* (R. Čaplar und W. Greiner, eds.), 1991, pp. 51–52.
52. N. Cindro, U. Abbondanno, W. Greiner, M. Bettiolo, M. Bruno, M. D'Agostino, P. M. Milazzo, R. A. Ricci, G. Vannini and L. Vanucci: *Resonances, superdefumation, high spin*, In: *Nuclear Physics of our Times* (Ramayya, ed.), World Scientific Publ. Co., Singapore, 1993, p. 423.
53. M. Korolija, D. Shapira and N. Cindro: *Exclusive measurement of p-p-fragment coincidences at 15 MeV/u*, Proc. of the Int. Symp. on *Reflections & Directions in Low Energy Heavy-Ion Physics*, JIHIR, Oak Ridge, TN, USA, 1993 (J. H. Hamilton, Chair.), World Scientific, Singapore, 1993, p. 163.
54. A. Gobbi (for the FOPI Collaboration): *Energy deposition in Au on Au collisions*, Proc. of the XX Winter Meeting on *Nuclear Physics* (I. Iori, ed.), Bormio, Italy, Univ. of Milano, Milano (Supp No. 97) (1994) 53–66.
55. S. Hölbling, Z. Basrak, N. Cindro, R. Čaplar and M. Dželalija (for the FOPI Collabora-tion): *Directed sidewards flow in Au+Au collisions at incident* energies *150-800 A MeV*, Proc. of the XXXII Winter Meeting on *Nuclear Physics* (I. Iori, ed.),

55. S. Hölbling, Z. Basrak, N. Cindro, R. Čaplar and M. Dželalija (for the FOPI Collabora-tion): *Directed sidewards flow in Au+Au collisions at incident* energies *150-800 A MeV*, Proc. of the XXXII Winter Meeting on *Nuclear Physics* (I. Iori, ed.), Bormio, Italy, Univ. of Milano, Milano (Supp. No. 97) (1994) 67– 76.
56. N. Cindro: *23rd Mazurian lakes – summer – school on nuclear physics,* Summary, Acta Physica Polonica B **25**(3-4) (1994) 779–788.
57. M. Dželalija, N. Cindro. Z. Basrak, R. Čaplar and S. Hölbling (for the FOPI Collaboration): *Entropy in entral Au+Au collisions at relativistic energies*, Proc. of the 7th Int. Conf. on *Nuclear Reaction Mechanisms* (E. Gadioli, ed.), Varenna, Italy, Univ. of Milano, Milano (Supp. No. 2) (1994) 649.
58. N. Cindro, U. Abbondanno, Z. Basrak, M. Bettiolo, M. Bruno, M. d'Agostino, P. M. Milazzo, R. A. Ricci, W. Scheid, J. Schmidt, G. Vannini and L. Vannucci: *The Ni+Ni puzzle: resonances in the scattering of medium heavy ions?*, Proc. of the Int. Conf. on *Nucl. Physics – Frontier Topics in Nuclear Physics* (W. Scheid and A. Sandulescu, eds.), Plenum Press, New York, 1994, pp. 421–431.

Časopis *Matematičko-fizički list*

1. *Katalitička nuklearna reakcija,* **(VIII)** (1957–1958) 21–22.
2. *Scintilacioni brojači,* **(VIII)** (1957–1958) 89–93.
3. *Zakoni očuvanja u fizici,* **(XVI)** (1965–1966) 108–112.
4. *Postoje li nakupine nukleona u jezgri,* **(XX)** (1969–1970) 145–147.
5. *Koliko znamo o atomskoj jezgri,* **(XXII)** (1971–1972) 49–51.
6. *Fizika 1970–1975, odabrana poglavlja,* (**XXVI**) (1975–1976) 49–58.
7. Fizika naših dana, (**XXIV**) (1983–1984) 117–123.
8. Max Born (1882. – 1970.) i James Franck (1882. – 1964.), **(XXXVI)** (1985–1986) 123–127.

Bormio, Italy, Univ. of Milano, Milano (Supp. No. 97) (1994) 67– 76.
56. N. Cindro: *23rd Mazurian lakes – summer – school on nuclear physics,* Summary, Acta Physica Polonica B **25**(3-4) (1994) 779–788.
57. M. Dželalija, N. Cindro. Z. Basrak, R. Čaplar and S. Hölbling (for the FOPI Collaboration): *Entropy in entral Au+Au collisions at relativistic energies*, Proc. of the 7th Int. Conf. on *Nuclear Reaction Mechanisms* (E. Gadioli, ed.), Varenna, Italy, Univ. of Milano, Milano (Supp. No. 2) (1994) 649.
58. N. Cindro, U. Abbondanno, Z. Basrak, M. Bettiolo, M. Bruno, M. d'Agostino, P. M. Milazzo, R. A. Ricci, W. Scheid, J. Schmidt, G. Vannini and L. Vannucci: *The Ni+Ni puzzle: resonances in the scattering of medium heavy ions?*, Proc. of the Int. Conf. on *Nucl. Physics – Frontier Topics in Nuclear Physics* (W. Scheid and A. Sandulescu, eds.), Plenum Press, New York, 1994, pp. 421–431.

Publications in the journal *Matematičko-fizički list*

1. *Katalitička nuklearna reakcija,* **(VIII)** (1957–1958) 21–22.
2. *Scintilacioni brojači,* **(VIII)** (1957–1958) 89–93.
3. *Zakoni očuvanja u fizici,* **(XVI)** (1965–1966) 108–112.
4. *Postoje li nakupine nukleona u jezgri,* **(XX)** (1969–1970) 145–147.
5. *Koliko znamo o atomskoj jezgri,* (**XXII**) (1971–1972) 49–51.
6. *Fizika 1970–1975, odabrana poglavlja,* (**XXVI**) (1975–1976) 49–58.
7. *Fizika naših dana*, (**XXIV**) (1983–1984) 117–123.
8. *Max Born (1882. – 1970.) i James Franck (1882. – 1964.),* **(XXXVI)** (1985–1986) 123–127.
9. *Klasični i kvantni pristup prirodi ili zašto su svi atomi zlata međusobno jednaki*, (**XLI**) (1990–1991) 91–93.

9. *Klasični i kvantni pristup prirodi ili zašto su svi atomi zlata međusobno jednaki*, (**XLI**) (1990–1991) 91–93.

Časopis *Priroda*

1. *Nuklearna zima*, **73**(4) (1984) 99.
2. *Peta sila u prirodi*, **74**(7-8) (1986) 216.
3. *Molekularne strukture u atomskoj jezgri,* **75**(1) (1986) 14.
4. *Černobil, Krško – mrak i budućnost*, **75**(3) (1986) 85–86.
5. *Nuklearni klub danas – koliko ima članova*, **75**(9-10) (1987) 293–295.
6. *Jugoslavenska fizika očima drugih*, **76**(1) (1987) 13–14.
7. M. Boranić, N. Cindro, Dina Keglević, Biserka Kojić-Prodić, Greta Pifat-Mrzljak, V. Pravdić i B. Vitale: *Institut „Rugjer Bošković"*, **76**(7) (1988) 183–187.

Ostali časopisi

1. N. Cindro: *Otkriće elementa 111: lov na superteške elemente*, Encyclopedia moderna **45** (1995) 23–25.
2. N. Cindro: *Prirodne znanosti na prijelazu tisućljeća: nuklearna fizika*, Rugjer, svibanj/lipanj 1996.
3. N. Cindro: *Einsteinovo vrijeme*, Rugjer, rujan 1996.

Poglavlja u knjigama i zbornicima radova

1. Nikola Cindro: *Superteški elementi*, poglavlje u knjizi: *Atom vodi igru*, Školska knjiga, Zagreb, 1973., str. 197–209.
2. Nikola Cindro: *Dva desetljeća burnog napretka fizike*, Zbornik trećeg programa radio Zagreba, Zagreb, 1985., br. 12, str. 146–152.
3. Nikola Cindro: *Razlozi za kvantnu teoriju*, Zbornik ljetne škole mladih fizičara, Društvo matematičara i fizičara SR Hrvatske, Zagreb, 1987., str. 8–14.
4. Nikola Cindro: *Umjesto uvoda*, 1-2, Spomenica: Institut „Ruđer Bošković" 1950–1990.

Publications in the journal *Priroda*

1. *Nuklearna zima*, **73**(4) (1984) 99.
2. *Peta sila u prirodi*, **74**(7-8) (1986) 216.
3. *Molekularne strukture u atomskoj jezgri,* **75**(1) (1986) 14.
4. *Černobil, Krško – mrak i budućnost*, **75**(3) (1986) 85–86.
5. *Nuklearni klub danas – koliko ima članova*, **75**(9-10) (1987) 293–295.
6. *Jugoslavenska fizika očima drugih*, **76**(1) (1987) 13–14.
7. M. Boranić, N. Cindro, Dina Keglević, Biserka Kojić-Prodić, Greta Pifat-Mrzljak, V. Pravdić i B. Vitale: *Institut „Rugjer Bošković"*, **76**(7) (1988) 183–187.

Other journals

1. N. Cindro: *Otkriće elementa 111: lov na superteške elemente*, Encyclopedia moderna **45** (1995) 23–25.
2. N. Cindro: *Prirodne znanosti na prijelazu tisućljeća: nuklearna fizika*, Rugjer, svibanj/lipanj 1996.
3. N. Cindro: *Einsteinovo vrijeme*, Rugjer, rujan 1996.

Book chapters and proceedings

1. Nikola Cindro: *Superteški elementi*, poglavlje u knjizi: *Atom vodi igru*, Školska knjiga, Zagreb, 1973., str. 197–209.
2. Nikola Cindro: *Dva desetljeća burnog napretka fizike*, Zbornik trećeg programa radio Zagreba, Zagreb, 1985., br. 12, str. 146–152.
3. Nikola Cindro: *Razlozi za kvantnu teoriju*, Zbornik ljetne škole mladih fizičara, Društvo matematičara i fizičara SR Hrvatske, Zagreb, 1987., str. 8–14.
4. Nikola Cindro: *Umjesto uvoda*, 1-2, Spomenica: Institut „Ruđer Bošković" 1950–1990.
5. Nikola Cindro: *Razmišljanja o primjeni scientometrije u ocjenjivanju znanosti i znanstvenika u*

5. Nikola Cindro: *Razmišljanja o primjeni scientometrije u ocjenjivanju znanosti i znanstvenika u Hrvatskoj*, poglavlje u knjizi: *Vidljiva i nevidljiva akademija*, Zagreb, 1998., str. 99–101.

Knjige i bilten

1. N. Cindro i P. Colić: *Fizika: odabrana poglavlja za fakultativnu nastavu fizike*, 2. izd., Školska knjiga, Zagreb, 1983.
2. *Fizika 1* (*Mehanika – Valovi – Toplina*), Školska knjiga, Zagreb, 1975. (1. izd.), 1980. (2. izd.), 1985. (3. izd.), 1988. (4. izd.)., svekupno 5 izdanja – zadnje 1991.
3. *Fizika 2* (*Elektricitet i magnetizam*), Školska knjiga, Zagreb, 1985. (1. izd.), 1988. (2. izd.), svekupno 3 izdanja – 3. izd. 1991.
4. *Fizika 1*. (suautor P. Colić), Školska knjiga, Zagreb, 1978. (1. izd.), 1983. (2. izd.), 1988. (3. izd.), svekupno 6 izdanja – zadnje 1992.
5. *Fizika 2* (suautor P. Colić), Školska knjiga, Zagreb, 1987. (1. izd.). svekupno 4 izdanja – zadnje 1990.
6. N. Cindro: *A Course on Nuclear Reactions*, C.R.N. Strasbourg/COURS 87-01.
7. N. Cindro i P. Colić: *Materijal za fakultativnu nastavu* (1. razred), *Znanstveno-metodički bilten iz fizike*, br. 4, Društvo matematičara i fizičara SR Hrvatske, Zagreb, 1977.

Prijevod knjige

1. Frank Close: *Svemirska lukovica – Kvarkovi i priroda svemira*, Školska knjiga, 1997.

Zaključno

Najpotpuniji popis Cindrinih radova do sada iznosio je 139 referencija. On se u ovome radu dopunjuje s još 90 referencija pa ukupni popis njegovih referencija iznosi 229. Novonavedenih 90 referencija grupirano je u pet kategorija: radovi u časopisima i zbornicima (58), stručni i popularni radovi (19), knjige i bilten (7), po-

Hrvatskoj, poglavlje u knjizi: *Vidljiva i nevidljiva akademija*, Zagreb, 1998., str. 99–101.

Books and bulletin

1. N. Cindro i P. Colić: *Fizika: odabrana poglavlja za fakultativnu nastavu fizike*, 2. izd., Školska knjiga, Zagreb, 1983.
2. *Fizika 1* (*Mehanika – Valovi – Toplina*), Školska knjiga, Zagreb, 1975. (1. izd.), 1980. (2. izd.), 1985. (3. izd.), 1988. (4. izd.)., svekupno 5 izdanja – zadnje 1991.
3. *Fizika 2* (*Elektricitet i magnetizam*), Školska knjiga, Zagreb, 1985. (1. izd.), 1988. (2. izd.), svekupno 3 izdanja – 3. izd. 1991.
4. *Fizika 1*. (suautor P. Colić), Školska knjiga, Zagreb, 1978. (1. izd.), 1983. (2. izd.), 1988. (3. izd.), svekupno 6 izdanja – zadnje 1992.
5. *Fizika 2* (suautor P. Colić), Školska knjiga, Zagreb, 1987. (1. izd.). svekupno 4 izdanja – zadnje 1990.
6. N. Cindro: *A Course on Nuclear Reactions*, C.R.N. Strasbourg/COURS 87-01.
7. N. Cindro i P. Colić: *Materijal za fakultativnu nastavu* (1. razred), *Znanstveno-metodički bilten iz fizike*, br. 4, Društvo matematičara i fizičara SR Hrvatske, Zagreb, 1977.

The book translation

1. Frank Close: *Svemirska lukovica – Kvarkovi i priroda svemira*, Školska knjiga, Zagreb, 1997.

The final word

The most complete list of N. Cindro's publications consists of 139 entries (15). Here we have added another 90 entries so the total list of his publications gives 229 entries. New entries are grouped into five different categories: 58 in other journals and proceedings, 19 popular texts, 7 books and bulletin, 5 book chapters and proceed-

glavlja u knjigama i zbornicima radova (5) i prijevod knjige (1). Na osnovi navedenog može se zaključiti da je Cindro imao značajniju ulogu u povijesti publicistike fizike nego što se dosad pretpostavljalo.

ZAHVALA

Autori zahvaljuju obitelji Cindro, osobito gospođi Željki, supruzi Nikole Cindre, sinu Branku i unuku Nikoli na korisnim informacijama i ustupanju dokumentacije iz obiteljske ostavštine obitelji Cindro. Zahvala pripada i gospođi Gordani Stubičan Ladešić, voditeljici Središnje knjižnice za fiziku, na pomoći pri skupljanju podataka za autorsku bibliografiju Nikole Cindre.

ings, and 1 book translation. It is more than evident that N. Cindro had an important role in the history of physics publications, much more than it has been assumed.

ACKNOWLEDGMENTS

The authors of the paper feel obliged to thank the family of Cindro, especially N. Cindro's spouse Ms. Željka Cindro, the son Branko and the grandson Nikola for information and documentation from the family Cindro legacy.
The authors want to thank Ms. Gordana Stubičan Ladešić, the Head of the Central Physics Library for her help in collecting data for the bibliography of Nikola Cindro.

LITERATURA I IZVORI / *REFERENCES AND OTHER SOURCES*

1. Izvod iz matične knjige rođenih za Nikolu Cindru / *Birth certificate for Nikola Cindro.*
2. Zoran Basrak: *In memoriam – Nikola pl. Cindro*, Matematičko-fizički list **LII** (2001–2002) 63–64.
3. Opis života (rukopis) Nikole Cindre */ Curriculum vitae (handwritten) of Nikola Cindro,* Arhiv Instituta „Ruđer Bošković", Zagreb, 1954.
4. Opis života (strojopis) Nikole Cindre */ Curriculum vitae (typed) of Nikola Cindro*, Arhiv Instituta „Ruđer Bošković", Zagreb, 1963.
5. Osnovni podatci u službenom kartonu Nikole Cindre / *Basic data from an official personal document for Nikola Cindro.*
6. Spomenica, 40. obljetnica Fakulteta elektrotehnike i računarstva, 1956–1996 / *Memorial, 40 Years of Faculty of Electrical Engineering and Computing 1956–1996,* Zagreb, 1996., str. 266.
7. Biografski podaci (strojopis) Nikole Cindre */ Biographical data (typed) of Nikola Cindro,* Arhiv Instituta „Ruđer Bošković", Zagreb, 1976.
8. *CINDRO, Nikola*, *Hrvatski biografski leksikon*, 2, Bj-C, Jugoslavenski leksikografski zavod „Miroslav Krleža", Zagreb, 1989., str. 672–673.
9. Ljetopis Hrvatske akademije za godinu 1995. / *Annals of Hrvatska akademija for the year 1995.,* knj. 99, Zagreb, 1996.
10. Osobni karton radnika Nikole, Mihovila, Cindre / *Personal working document for the emplyee Nikola, Mihovil, Cindro*.
11. Arhiv Instituta „Ruđer Bošković" / *Archives of the Institute Ruđer Bošković*, Zagreb.
12. *Crne liste i supergravitacija*, Slobodna Dalmacija, 23. svibnja 1992., str. 30–31.

13. Zakon o doktoratu nauka / *The law about doctorate in sciences*, Službeni list FNR Jugoslavije, 5. srpnja 1955., br. 29.
14. Arhiv Rektorata Sveučilišta u Zagrebu /Archives: Rektorat Sveučilišta u Zagrebu.
15. Z. Basrak, R. Čaplar i V. Paar: *Nikola Cindro, in memoriam*, Fizika B **12**(1) (2003) III–XX.
16. Matematičko-fizički list, Vol. **VIII, XVI**, **XX**, **XXII**, **XXVI**, **XXXIV**, **XXXVI**.
17. Priroda **(72–73)** (1984), **(74–75)** (1986), **(75–76)** (1987), **(76–77)** (1988).