Vijay

Celebrating Vijay Pandharipande: A Symposium

University of Illinois at Urbana-Champaign
141 Loomis Laboratory of Physics
September 29 & 30, 2006

Vijay Pandharipande

The leading nuclear theorist of his generation

Unique contributions and insights across broad spectrum of many-particle problems

Bob Wiringa, Argonne • *Nuclear matter and nuclear forces*

Chris Pethick, Nordita • *Neutron stars*

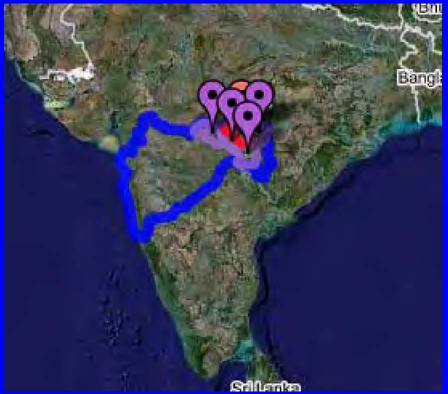
Tony Leggett, UIUC • *Condensed matter physics*

Joe Carlson, Los Alamos • *Light nuclei*

Ingo Sick, Basel • *Electrons and nuclei*

Wick Haxton, U. Washington • *Looking to the future*

A short biography



*Born August 7, 1940: Nagpur, India

*Nagpur University: B.Sc.1959, M.Sc.1961

*Research Assistant → Fellow in experimental nuclear physics: Tata Institute, 1961-1973

*Ph.D. Bombay University, 1969

*Fellow, Niels Bohr Institute, Copenhagen, 1969-1971

*Postdoctoral Fellow, Cornell, 1972

*Joins faculty in Urbana, Fall 1972

*Bonner Prize, APS 1999

*Center for Advanced Study Professor of Physics and Willet Professor of Engineering.

Began doing experimental physics: 7 papers 1963-68

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3.A

Nuclear Physics **A109** (1968) 81—93; © *North-Holland Publishing Co., Amsterdam*

LEVEL STRUCTURE OF ^{117}In FROM THE DECAY OF ^{117}Cd

V. R. PANDHARIPANDE, K. G. PRASAD, R. P. SHARMA and B. V. THOSAR

Tata Institute of Fundamental Research, Bombay, India

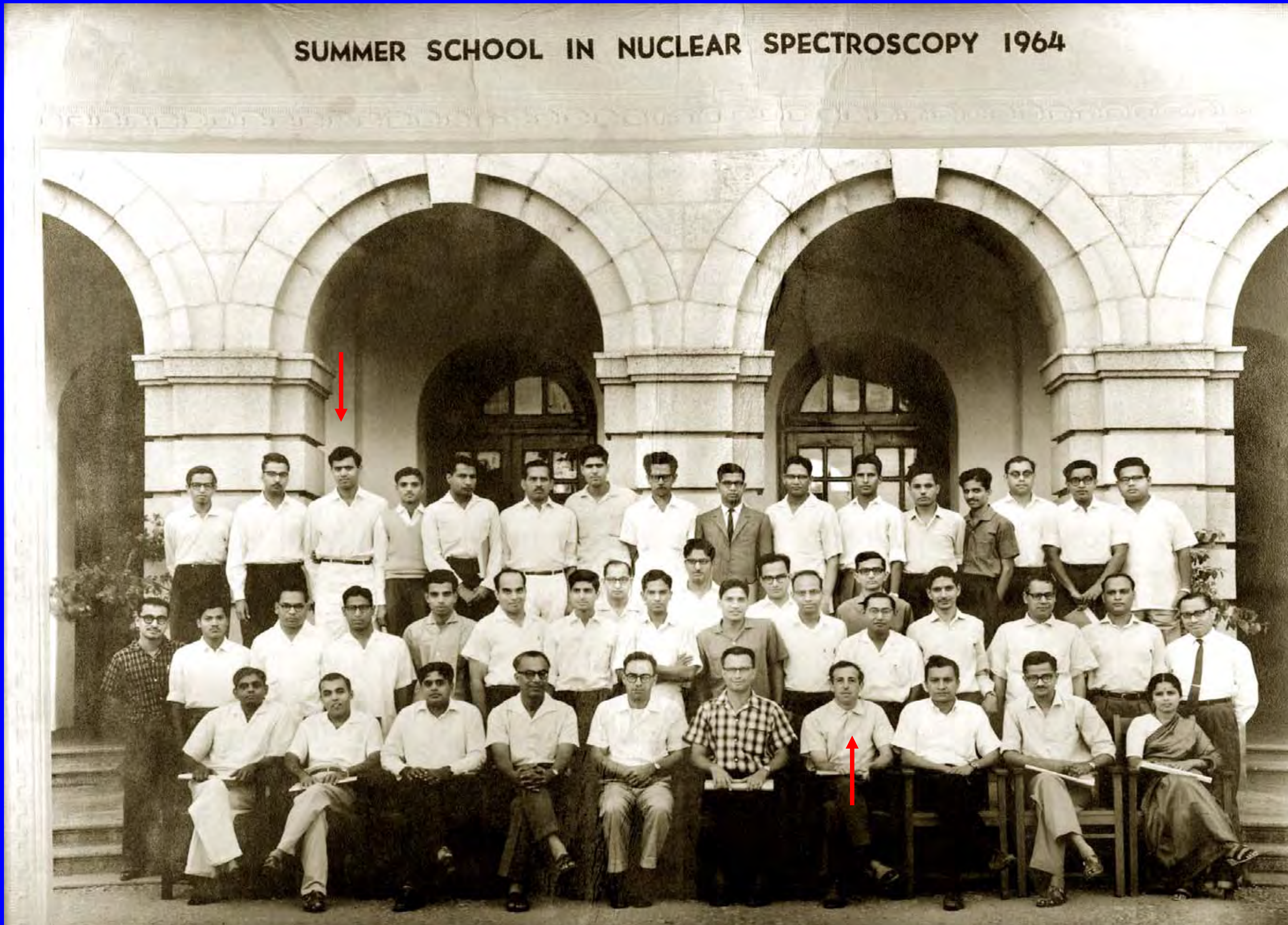
Received 9 November 1967

Abstract: The levels in ^{117}In populated in the decay of $\approx$ 2.7 h ^{117}Cd and ^{117m}Cd have been studied using a Ge(Li) detector and scintillation techniques. In all 45 gamma rays have been identified. A total of 23 energy levels extending up to 2461 keV has been proposed on the basis of the gamma-gamma and beta-gamma coincidence measurements. The K-conversion coefficient of the 88 keV transition is measured to be 1.3 ± 0.3. The gamma-gamma directional correlations of 1028-1068 keV and 567-1430 keV cascades have been found to be

$$W(\theta) = 1 - 0.022(\pm 0.012)P_2(\cos\theta) + 0.015(\pm 0.038)P_4(\cos\theta),$$

$$W(\theta) = 1 - 0.011(\pm 0.012)P_2(\cos\theta) + 0.060(\pm 0.038)P_4(\cos\theta).$$

The beta-gamma differential correlation of the beta group feeding the 748 keV level and the following 433 keV gamma ray is found to be isotropic. The levels at 660, 748, 881, 1249 and 1715 keV have been identified as the members of a possible $K = \frac{1}{2}^+$ rotational band. The levels at 860, 950, 1056, 1068 and 1430 keV have been suggested to be the members of a ($\frac{9}{2}^+$ proton hole $+2^+$ core) multiplet. The possible nature of the other higher-excited states has been discussed.


SUMMER SCHOOL IN NUCLEAR SPECTROSCOPY 1964

First theory paper:

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Nuclear Physics **A100** (1967) 449—455; © *North-Holland Publishing Co., Amsterdam*

AN EFFECTIVE, RESIDUAL INTERACTION FOR SHELL-MODEL CALCULATIONS

V. R. PANDHARIPANDE

Tata Institute of Fundamental Research, Bombay-5, India

Received 10 April 1967

Abstract A modified δ-function, effective, residual interaction is proposed for nuclear, shell-model calculations. The interaction V^{12} is defined as follows

$$\langle j_1 j_2 J | V^{12} | j_3 j_4 J \rangle = \alpha_J \langle j_1 j_2 J | V\delta(r_1 - r_2)[1 - \beta + \beta(\boldsymbol{\sigma}_1 \cdot \boldsymbol{\sigma}_2)] | j_3 j_4 J \rangle,$$

$$\alpha_J = 1 \quad \text{if} \quad J \neq j_1 \pm j_2 \qquad J \neq j_3 \pm j_4,$$

$$\alpha_J = a + bJ \quad \text{if} \quad J = j_1 \pm j_2 \quad \text{or} \quad J = j_3 \pm j_4$$

Calculations with this interaction are presented in ^{18}O, ^{38}Cl, ^{42}Ca, ^{54}Fe, ^{90}Zr, ^{92}Nb, ^{92}Zr and ^{210}Bi. The interaction gives good agreement in all these isotopes with the following values of the parameters

$$V = 1630 \text{ MeV} \cdot \text{fm}^3, \qquad \beta = 0.1,$$

$$a = 0.42, \qquad b = 0.05$$

Calculations in even tin and odd indium isotopes are also presented

Copenhagen ca. 1970

Vijay
Hans Bethe with his students Phil Siemens, John Negele,
From Urbana: Chris Pethick, David Pines, GB

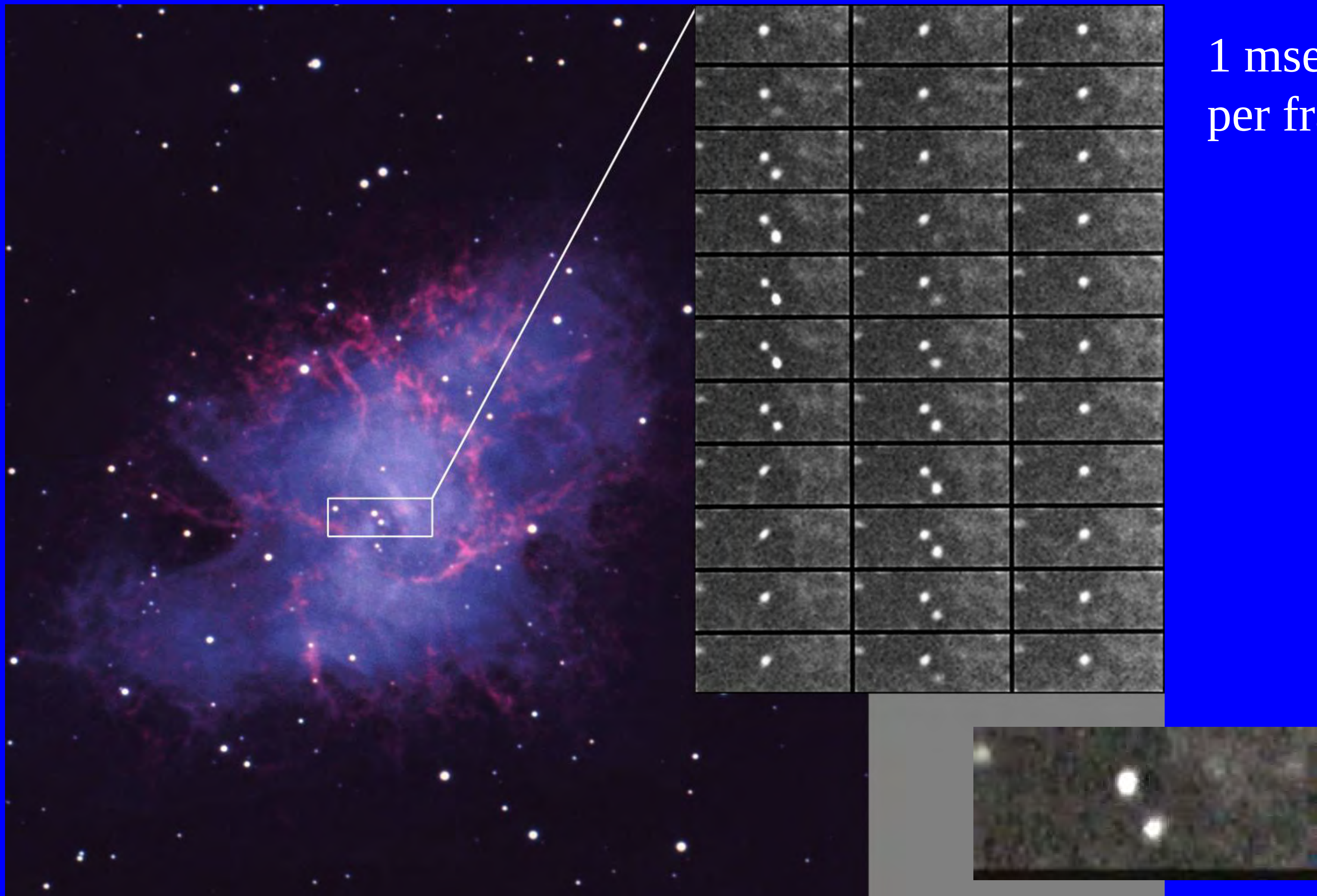
Pulsars discovered in 1967-8.
Identified as rotating neutron stars.

The beginnings in Copenhagen of program to understand properties of neutron stars – major activity over the years in Urbana: Vijay, GB, Fred Lamb, Chris Pethick, David Pines, Geoff Ravenhall, Stu Shapiro

Niels Bohr Institute, October 1970

Crab Pulsar (period = 33 msec)

Supernova July 4, 1054

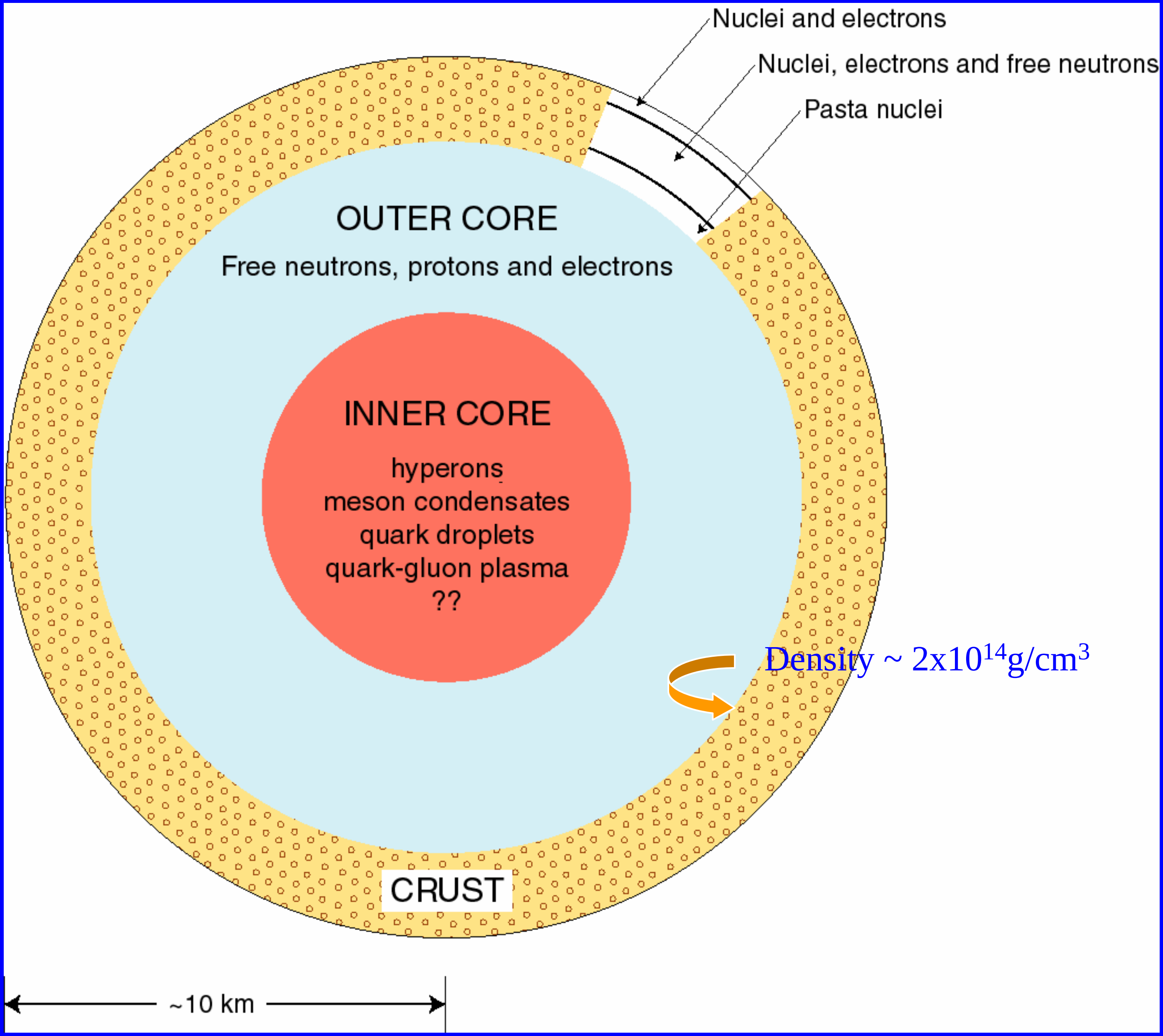


1 msec
per frame

Cross section of a neutron star

Mass ~ 1.4 M_{sun}
Radius ~ 10-12 km
Temperature
~ 10^6-10^9 K

Surface gravity
~10^{14} that of Earth
Surface binding
~ 1/10 mc^2
Mountains < 1 mm



Vijay’s early work on neutron stars

Dense neutron matter with realistic interactions
Nucl. Phys. **A174**, 641 (1971)

Neutron matter computations in Brueckner and variational theories
P. J. Siemens and VRP, Nucl. Phys. **A173**, 561 (1971)

Hyperonic matter Nucl. Phys. **A178**, 123 (1971)

Variational calculation of nuclear matter Nucl. Phys. **A181**, 33 (1972)

1.C

Nuclear Physics **A174** (1971) 641—656;

DENSE NEUTRON MATTER WITH REALISTIC INTERACTIONS

V. R. PANDHARIPANDE

The Niels Bohr Institute, Copenhagen, Denmark

and

Tata Institute of Fundamental Research, Bombay-5, India

Received 1 September 1970

(Revised 24 June 1971)

Abstract: The energy of the neutron gas is studied with the Reid and Bressel-Kerman-Rouben soft-core potentials up to a density of 4.5 neutrons/fm^3. Very approximate estimates for neutron gas and solid energies are presented also for the Hamada-Johnston hard-core potential. The short-range correlations are treated by a simple variational method in which the cluster expansion of the energy expectation value, with a Jastrow wave function is truncated at the lowest-order two-body clusters. Healing constraints are introduced in the variation from qualitative comparison with lowest-order Brueckner theory and a differential equation is obtained for the correlation function by minimizing the energy. The effective interaction for use with uncorrelated wave functions, given by this procedure is also interpreted with the Moszkowski-Scott separation method. It is shown that the lowest-order calculations may be reasonable for the Reid and Bressel-Kerman-Rouben soft core potentials, whereas their applicability with Hamada-Johnston hard-core potential is doubtful for $\rho \gtrsim 0.7$ fm^{-3}. The results give an approximate equation of state for dense neutron matter and the order of uncertainty in it due to that in neutron-neutron interaction at short range, and may be useful in neutron star structure investigations.

THE GROUND STATE OF MATTER AT HIGH DENSITIES: EQUATION OF STATE AND STELLAR MODELS*

GORDON BAYM, CHRISTOPHER PETHICK,† AND PETER SUTHERLAND
Department of Physics, University of Illinois, Urbana

Ap. J. (1971)

To discuss the equation of state in the uniform-liquid phase, one can employ the standard techniques of nuclear-matter theory with some confidence up to about 5×10^{14} g cm^{-3}. BBP give the equation of state, based on Siemens's (1971) neutron-matter calculations, up to this density. The equation of state beyond this density is very uncertain, since, on the one hand, one has little knowledge of the forces between the various hyperons present in the matter there and, on the other hand, the particle density is sufficiently high that the conventional techniques of nuclear matter theory begin to require modification. To acquire some feeling for the stellar models with central densities in this region, we shall explore the consequences of one extension given by Pandharipande (1971) of the equation of state to very high densities, namely, his model C. This calculation allows for the presence of n, p, e, μ^-, Λ, $\Sigma^{\pm}$, Σ^0, $\Delta^{\pm}$, and Δ^0 in the matter, and assumes that the interactions involving hyperons are given by the $T = 1$ component of the Reid soft core potential, modified by omitting the one-pion-exchange part and reducing by 10 percent the intermediate-range attraction. The interaction between pairs of nucleons is the Reid soft core potential. The equation of state was calculated by assuming a Jastrow-type wave function, including only up to two-body clusters.

Vijay comes to Cornell (1971) and then Urbana (1972)

with G. Baym and Hans Bethe, ca. 1976

Vijay
in
Urbana

Vijay in his office
337A in Loomis


door E. SOLVAY, V.Z.W.
nseil de Physique - Bruxelles 24 sept. - 28 sept. 1973
XVIe Raad voor Fysica - Brussel 24 sept. - 28 sept. 1973

Urbana 1972

Al Hansen, Aage Bohr, Peter Axel,
Vijay, G.B., Carol Bennett, Chris Pethick, Naoki Itoh

University of Illinois
at Urbana-Champaign

DEPARTMENT OF PHYSICS
Urbana, Illinois 61801

MEMORANDUM

Date: 8/25/75

To: V. R. Pandharipande
From: RO Simmons
Re: Nuclear Physics Seminar Account

Your account is now $121 "overdrawn", with $821 having been spent from a (revised) allocation of $700. I trust that you will "cease and desist" with any paid outside speakers for the rest of the year!

copy: H.C. Gersbaugh

First Urbana Workshop on Dense Matter, Apr. 6-7, 1973

WORKSHOP ON DENSE MATTER

Program

Friday, April 6, 1973 - Room 151 --- *DO NEUTRONS SOLIDIFY UNDER PRESSURE?*

9:30--10:15 ...... D. Pines: The observations seem to indicate that they do.

10:45--11:45 ..... V. Canuto and S. M. Chitre: Yes, but it takes quite a heavy pulsar.

1:45--2:45 ...... L. N. Nosanow and L. Parish: It is easy, most of the pulsars have solid cores.

3:15--4:15 ...... V. R. Pandharipande: Pulsars can't make neutrons solidify.

Saturday, April 7, 1973 - Room 144 --- *DO PIONS CONDENSE IN NEUTRON MATTER?*

9:30--10:30 ...... H. A. Bethe: Just possibly.

10:30--11:30 ...... G. Baym: If so, then here's how.

NOTE: These are not titles but my impressions of the speakers recent views on the subject.

V. R. Pandharipande


Workshop on Nuclear and Dense Matter, May 3-6, 1977, Urbana, Illinois

Vijay as teacher

Single-handedly shaped new generation of nuclear theorists

Some twenty Ph.D. students

Many postdocs and collaborators forming closely knit international scientific family

VIJAY'S GRAD STUDENTS

Ph.D.

- Arya Akmal
- Alexander Belic
- Joe Carlson
- Soon-Yong Chang
- Shannon Cowell
- Jun Forest
- Barry Friedman
- Roger Loucks
- Stratos Manousakis
- Mark Paris
- Brian Pudliner
- Thomas Schlagel
- Kevin Schmidt
- Bob Wiringa

Current

- Jaime Morales
- Abhishek Mukherjee
- Alexandros Gezerlis

and

- Daniel Lewart
- Bob Lenk

Vijay's (theory) collaborators

P. J. Siemens 1971
V. K. Garde 1972
H. A. Bethe 1973
N. Itoh 1973
R. A. Smith 1975
R. B. Wiringa 1975
B. D. Day 1975
D. Pines 1976
K. E. Schmidt 1977
I. E. Lagaris 1979
J. Lomnitz-Adler 1980
B. Friedman 1981
S. Fantoni 1981
B. L. Friman 1981
J. Carlson 1981
Q. N. Usmani 1981
J. Kogut 1983
S. C. Pieper, 1983
J. G. Zabolitzky, U. Helmbrecht 1983

E. Manousakis 1983
C. N. Papanicolas, J. Wambach 1984
S. C. Pieper 1985
R. J. Lenk 1986
T. J. Schlagel 1987
R. Schiavilla, D. S. Lewart 1987
A. Fabrocini 1987
D. O. Riska 1989
A. Arriaga 1991
O. Benhar, G. A. Miller, I. Sick 1991
R. J. Loucks 1994
M. R. Radici, S. Boffi 1994
B. S. Pudliner 1995
J. L. Forest, J. L. Friar 1995
C. J. Pethick, V. Thorsson 1995
A. Smerzi, D. G. Ravenhall 1996
H. Gao, R. J. Holt 1996
P. K. A. deWitt Huberts 1997
A. Akmal 1997

... collaborators

D. Van Neck, M. Waroquier, A. E. L. Dieperink 1998
V. G. J. Stoks, W. Glöckle, H. Kamada, A. Nogga, R. Machleidt, A. Kievsky,
S. Rosati, M. Viviani 1998
M. W. Paris 2000
H. Heiselberg (2000)
K. Varga (2002)
I. E. Mazets (2002)
S. Cowell 2003
T.-S. Park, L. E. Marcucci, M. Viviani, S. Rosati, K. Kubodera,
D.-P. Min, M. Rho 2003
L. Brulla, A. Sarsa, S. A. Vitello 2003
S.-Y. Chang 2003
J. Morales Jr. 2003
I. A. Morrison, T. W. Baumgarte, S. L. Shapiro 2004
D. R. Phillips, U. van Kolck 2005
L. E. Marcucci 2005
J. P. Schiffer 2005

Vijay R. Pandharipande Prize in Nuclear Physics

An annual award honoring the
year's most outstanding graduate
student in nuclear physics