個人情報

所属学会

- 日本物理学会、応用物理学会、アメリカ物理学会、英国物理学会

受賞等

- アメリカ物理学会フェロー称号(1995.11)「For contributions to the understanding of the dynamics of fractal structures and of the Kapitza resistance at mK temperatures」
- 英国物理学会フェロー称号(1999.11) 「For contributions to the development of condensed matter physics」
- Alexander von Humboldt Research Fellow Award (1978.12)

学位

- 工学博士（北海道大学）1973 年 3 月

  論文題目：六方晶セレン、テルルの原子間結合と格子力学

学会活動

- (社)応用物理学会理事（2004-2006）
- (社)応用物理学会評議員（2006-現在に至る）
- (社)応用物理学会評議員（1998.4-2004.3）
- (社)応用物理学会北海道支部· 支部長(2001.4-2003.3)
- (社)応用物理学会 教育· 公益事業アドバイザー(2004.3-2005.3)
- (社)応用物理学会 業績賞委員 （2004.4- 2006.3）
- (社)日本物理学会ジャーナル編集委員(1997.4-1999.3)
- (社)日本物理学会代議員(2000.4-2005.3)

資格等

- Chartered Physicist（英国物理学協会）(1996)
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学術活動

- Chairman of the 8th International Conference on Phonon Scattering in Condensed Matter (1995)
- Chairman of the 4th International Conference on Phonon Physics (1995)
- External Examiner for Doctor’s Thesis, The Chinese University of Hong Kong
- Advisory Committee of International Conference on Phonon Scattering in Condensed Matter,
- 新潟大学自然科学研究科外部評価委員会委員長
- 日本学術振興会審査会専門委員
- 文部科学省学術審議会専門委員
- 総合研究大学院大学博士論文審査委員
- アメリカ物理学会学術専門誌査読委員
- ヨーロッパ物理学会学術専門誌査読委員
- 東京大学物性研究所スーパー· コンピュータ共同利用課題審査委員
- 総合研究大学院大学博士論文審査委員
- 物性物理グループ百人委員会委員

他

社会貢献

- 北海道大学工学部同窓会理事長(2003.4-2004.3)
- 日本工学教育協会常任理事(2006.4-2008.3)
- 北海道大学工学部同窓会幹事(2002.4-2003.3)
- 北海道大学工学部同総会顧問(2004.4-)
- 日本工学教育協会常任理事(2006.4)
- 札幌銀行中小企業新技術助成基金技術審査委員会審査委員(2004.4-2006.3)

他

他大学非常勤講師

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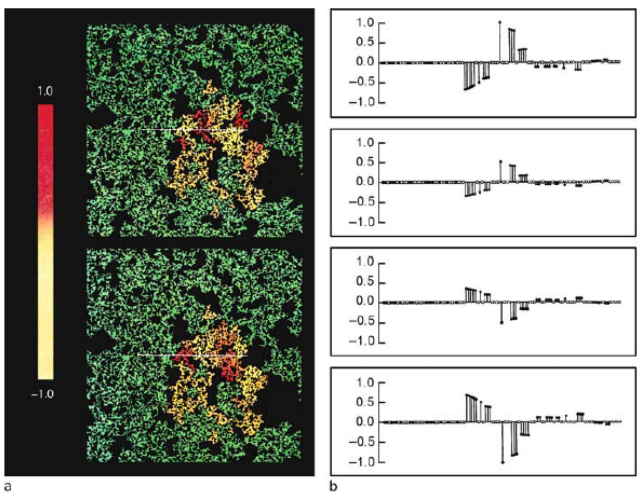
教育活動

教育研究評議会委員 部局長連絡会議委員　教務委員会委員 国際交流委員会委員 研究推進委員会委員 21 世紀 COE 推進委員会委員 人事委員会委員　留学生専門教育委員　入学者選抜委員会委員　高等教育機能開発総合センター運営委員会委員　北海道大学事業場札幌キャンパス安全監督者委員　教務委員会委員 研究推進委員会委員　観光学高等研究センター運営委員会委員　北海道大学情報処理教育センター運営委員会委員　北海道大学言語文化部共同利用委員会委員　北海道大学大学院理学研究科物理学専攻設置準備委員会委員　北海道大学量子干渉方式伝道度領域磁化測定研究室運営委員会委員　北海道大学量子界面エレクトロニクス研究センター運営委員会委員　北海道大学量子界面エレクトロニクス研究センター点検評価委員　他

研究成果

1．フラクタル構造における「フラクトン励起」概念の確立

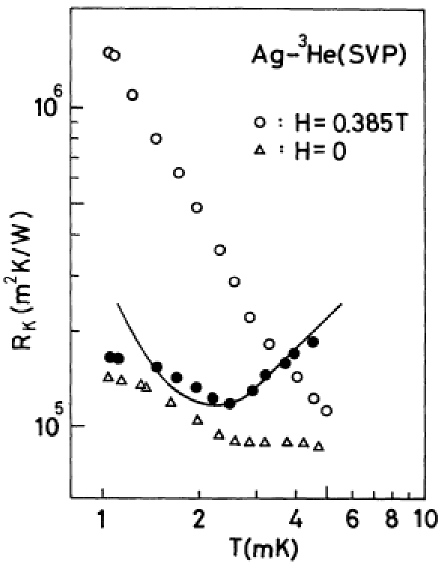
20 世紀の物理学の展開を振り返ると、研究対象が分子から原子、そして原子核からクオークへと、より微小なものの探査に向けられた一方、凝縮系物理学で生み出された対称性の破れという概念を取り込み、宇宙創生の解明に関する研究につながるなど、その成果は人類史に残るものであると云えよう。しかし 1980 年代に入り、このようなスケールの大小にかかわらず自然を支配する普遍的な法則があることも明らかになり、この分野の研究は大きく進化する。「フラクタル」と名付けられたスケール不変な構造は、宇宙空間の星雲の分布から原子･ 分子凝集体に至るまで自然界に多く見いだされることになった。1980 年代半ばからの中山と矢久保による共同研究により、フラクタル構造に特有なダイナミックスを支配するフラクトン励起の特性が明らかになった。これらのパイオニア的研究は、フラクタル構造のダイナミックスに関するその後の実験的･ 理論的研究を主導した。これにより、ランダムに見えるフラクタル構造に、単純な法則性が存在することが明らかになり、不規則系物理学分野の概念を一変させた。これらの一連の研究成果は、「Dynamical properties of fractal structures: scaling, numerical simulations and physical realizations」のタイトルのもと、物理学のコミュニティーでもっとも重要とされる総合報告誌「Reviews of Modern Physics」の 66 巻(1994)　pp. 381-443 に T. Nakayama, K. Yakubo, and R.Orbach の共著論文として報告された。この論文は現在でも様々な研究分野で広く引用されている。



図： 2 次元パーコレーションで励起された強局在フラクトン． コンピュータによる大規模計算結果．

2．ミリケルビン低温領域における熱交換メカニズム「異常カピッツア抵抗」の解明

近年、希釈冷凍機の普及により、ミリケルビン領域での物性測定は数 10 年前に比べずいぶん身近なものとなってきた。その理由は、希釈冷凍機の性能が飛躍的に上がったことがあげられる。熱交換効率を上げるには「液体 He^3 あるいは He^3 -He^4 希釈混合液と金属微粒子焼結体」からなる熱交換器の熱交換効率を高めなければならない。云いかえると低温になるとともに大きくなるカピッツァ界面熱抵抗を下げなければならない。熱交換効率を測る物理量であるカピッツア抵抗に、1mK 近くの超低温で異常が発見されたのは 1975 年のことである。爾来、超低温での熱交換の物理的機構の解明は、極低温物理学や極低温工学の分野で焦眉の課題であった。1980 年代初頭、中山は、超低温でのカピッツア抵抗において「He^3 核スピンと銀微粒子焼結体表面に化学吸着した酸素分子間の磁気的相互作用」が効いていることを理論的に予言した。その後、1996 年度のノーベル物理学賞受賞者であるスタンフォード大のオシェロフ教授達ならびにコーネル大学のリチャードソン教授達によるカピッツァ抵抗の磁場依存性に関する実験検証により、この機構の正しさが立証された。これらの一連の仕事は、低温物理学のコミュニティーにおけるもっとも著名な総合誌「Progress in Low Temperature Physics」12 巻 (1989) pp.117-194 に「Kapitza thermal boundary resistance and interactions of helium quasiparticles with surfaces」のタイトルのもと出版されている。



図：カピッツア抵抗 R_k の理論曲線 (---) と実験値 (●). 磁気チャンネルの存在が確立した . (1986 年)

3．大規模行列の固有値問題に対する数値アルゴリズム「強制振動子法」の開発

1980 年代の後半、中山は運動方程式の時間発展運動方程式を扱う分子動力学的方法が、「10^6x10^6 の大規模行列の固有値問題、すなわち固有値ならびに固有関数の計算、そしてスペクトル状態密度の計算において、どの方法よりも効率的である」ことを実証した。共同研究者の矢久保とともに、この方法をフラクタル構造のダイナミックスの研究に適用し、フラクトン励起の研究において世界を先導することになった。アルゴリズムの単純さに注目し、非エルミート行列の固有値問題へのこの方法の適用、並びに大規模量子系の線形応答関数の計算、すなわち久保公式の計算アルゴリズムの開発を行った。現在、このアルゴリズムは、強制振動子法(The forced oscillator method)とネーミングされ、物理の分野ばかりでなく、化学、電子工学などの分野で用いられている。強制振動子法の具体的なパーフォーマンスは、総合報告誌「Physics　Reports」の 349 巻, (2001), pp.239-299 に「The forced oscillator method: Eigenvalue analysis and computing linear response function」のタイトルのもとに T. Nakayama and K. Yakubo の共著として発表されている。

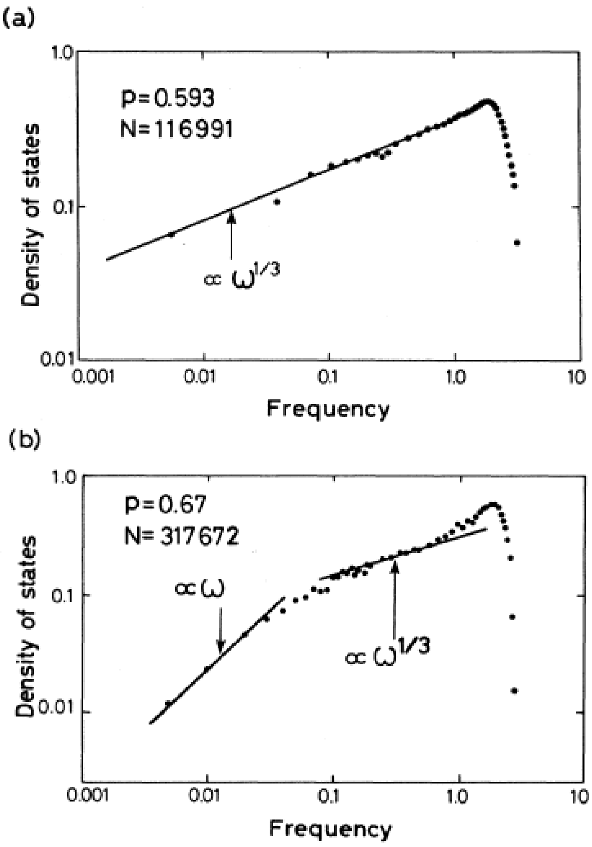
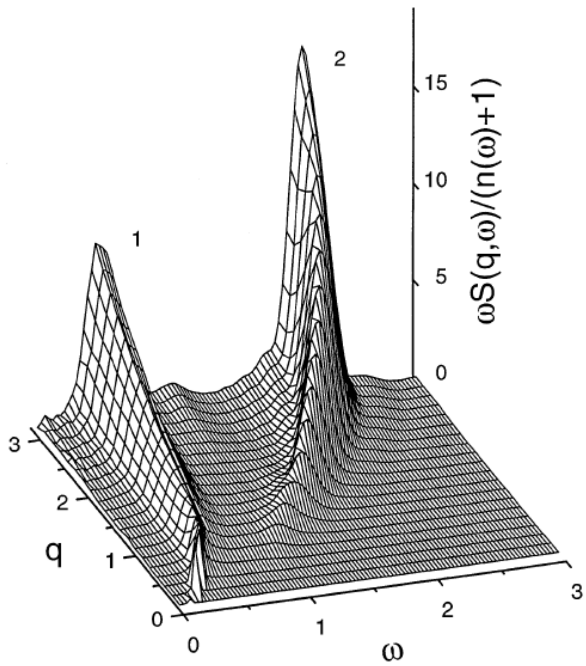


図 : 大規模 2 次元パーコレーションにおける状態密度の精密な計算結果、臨界点(a)と臨界点以下(b) （ 1987 ）

4.　構造ガラスにおける「ボソン・ピーク」の起源に関する研究

　ガラスは、五千年あまり昔のメソポタミアで作られた人類初の人工合成物であるが、近年 DVD への実用化や IT 関連材料などとしてあらたな注目を集めている。ガラスは融液を急冷しガラス転移温度 T_g を経由して得られ、乱れた構造と準安定性により特徴づけられる。これらのガラスでは、THz 振動数領域において通常の不規則系では見られない特異なモード、いわゆるボソン・ピークが出現する。ラーマン散乱実験による最初の発見は、1953 年にインドのクリシュナンによりなされた。そして比熱や熱伝導にも通常の不規則系では見られない特異な性質が見いだされた。構成原子によることなく普遍的に見いだされるボソン・ピーク発現の物理的機能を明らかにすべく、これまで国内外において多くの研究がなされてきた。中山は 1998 年に、異なる系に共通する特性のみを抽出した簡単なモデルを提唱し、この特異なモードが局在した光学モードのフラットバンドによるものであることを明らかにした。この予言は、1999 年に、J-RARC の新井正敏らによる、高分解能コヒ−レント中性子非弾性散乱実験で実証された。この分野の展開は、著名な総合報告誌「Reports in Progress in Physics」の 65 巻(2002) pp.1195-1242 に「Boson peak and terahertz frequency dynamics in vitreous silica」のタイトルのもとで出版された。



　図の説明：動的構造因子 S(q, ω)の計算結果．ボソン・ピークが、音響フォノン・バンドの中に出現することを最初に示したもの．(1998)

5) その他、主要なものとして

^{3}He 偏極スピンの生成に関する研究、光導波路の大規模数値解析アルゴリズム開発に関する研究、高温超伝導体における超伝導・絶縁体転移に関する研究、2 次元電子系における金属・絶縁体転移に関する研究、強相関コロイド粒子系のフラクタル凝集、に関する研究など物性一般に関わる多岐の研究がある。

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