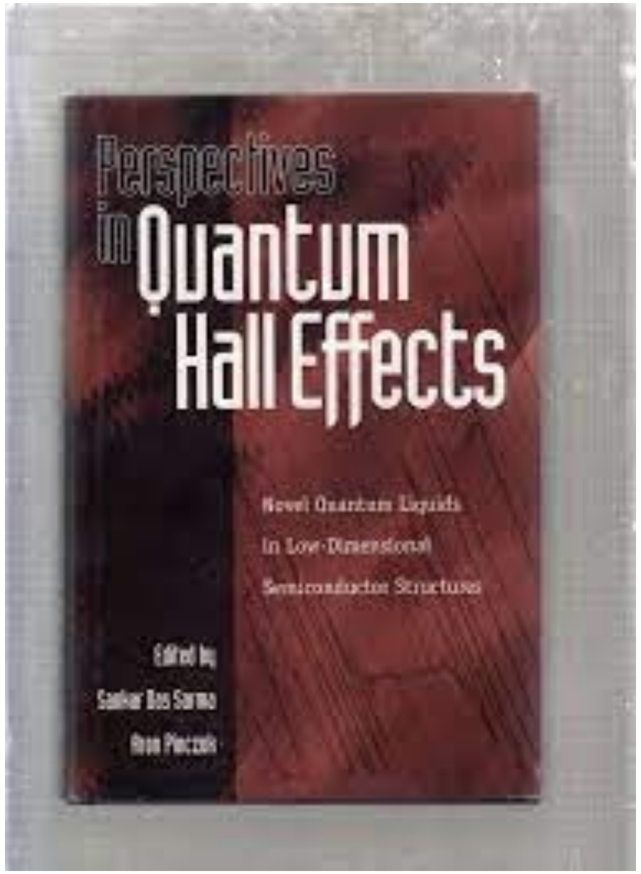
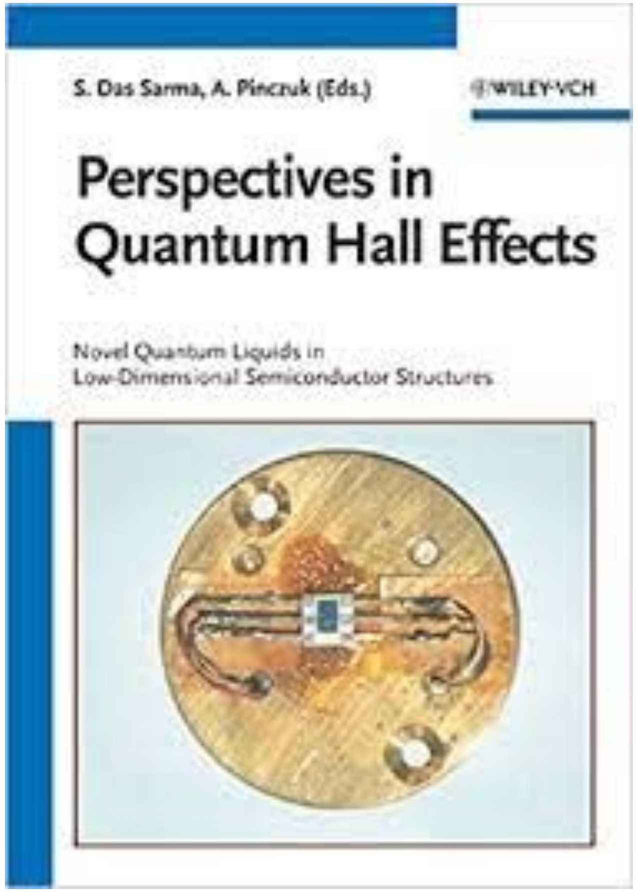
Aron Pinczuk: A Friend for 40 Years with Plasmon Modes in Our Minds





Absence of spin-density excitations in quasi two-dimensional electron systems

R. Decca, ***A. Pinczuk, S. Das Sarma***, S. Dennis, L. N. Pfeiffer, and K. W. West ***Phys. Rev. Lett. 72, 1506 (1994)***

Meeting Aron…..

- **I think it was late 1981 or early 1982…. ??**
- **I think it was at IBM in Yorktown Heights … ??**
- **What I do know is that he told me, by eagerly asking me about my work on (1981-82) predicting stable acoustic plasmons in semiconductor layers, that he was engaged in light scattering experiments at Bell Labs looking for these acoustic plasmons and might have already seen them**
- ***I had no idea how unusual this was: A senior Bell Labs experimental PI showing real interest in the work of an unknown theoretical postdoc***
- **I thought this was normal, and this is how physics works**
- **This was not normal: Aron Pinczuk was just very special**
- ***Thus began our ~ 40 year old close and special friendship (1981/82-2022)***

Some highlights of our friendship……

- **Prediction/observation of undamped 2D acoustic plasmons (1980s)**
- **Prediction/observation of 2D intersubband plasmons (1980s)**
- **Prediction/observation of 1D collective modes in quantum wires (1990s)**
- **Observation and understanding of SPE, SDE, CDE in 1/2/3D semiconductors**
- **Plasmons in very dilute systems and 2D Wigner crystals (early 2000)**
- **Collective modes in QHE and FQHE (late 1990s– 2022)**
- **QHE book (1994-95, 1996; 2010)**
- **Buckley Prize (1994) [Stormer]**
- **Horst Stormer retirement (2008 ??; 2011)**
- **Solid State Communications (2003-2018); Editorial Board; Executive Editor….**
- **Many conferences/workshops in ICTP Trieste; multiple APS symposia,……**

Exploring graphene
Recent research advances
Edited by Sankar Das Sarma, Andre K. Geim, Philip Kim, Allan H. MacDonald
Volume 143, Issues 1–2,Pages 1-126 (July 2007)

Recent Progress in Graphene Studies
Edited by Vladimir Fal'ko, Andre Geim, Sankar Das Sarma, Allan MacDonald, Philip Kim
Volume 149, Issues 27–28,Pages 1039-1160 (July 2009)

Emergent phenomena in quantum Hall systems -Emergent Phenomena in Quantum Hall Systems
Edited by
S. Das Sarma, *J. Eisenstein*, V. Pellegrini, S. Simon
Last update October 2006

Advances in Studies of Electrons in Low Dimensional Structures P. Hawrylak and S. Das Sarma
Last update September 2003

It was (almost) impossible to say 'no' to Aron Pinczuk
He had this exceptionally sweet way of asking!!
It took me a long to learn how to say 'no' to Aron

Proceedings of the High-Tc Superconductivity Workshop (HTSC Workshop 2002)
A. Millis, S. Uchida, Y. Uemura
Last update April 2003

Topological States in Condensed Matter: Physics and Materials Science
Volumes 215–216, Pages 1-62 (July 2015)
Edited by: Cheng Xie, Allan H. MacDonald, Qi-Kun Xue, Moty Heiblum

Exploring Graphene, Recent Research Advances Edited by Luis Brey, Rodney Ruoff, Klaus Ensslin, Philip Kim
Last update August 2012

From APS Journal 'Search':

Pinczuk cited Das Sarma/Jain/Stormer/Eisenstein: 37/23/35/22 out of 89 total publications

From APS Journal 'Search':

Das Sarma cited Pinczuk/Jain/Stormer/Eisenstein: 72/81/132/94 out of ?? total publications

Does this (72>37) imply that Das Sarma is a better friend of Pinczuk than the reverse? It depends....

?? = 833: 37/89~0.42>> 0.09 =72/833 !

PHYSICAL REVIEW B VOLUME 23, NUMBER 2 15 JANUARY 1981

Collective modes of spatially separated, two-component, two-dimensional plasma in solids

S. Das Sarma and A. Madhukar

PHYSICAL REVIEW B VOLUME 25, NUMBER 12 15 JUNE 1982

Collective excitations in semiconductor superlattices

S. Das Sarma

PHYSICAL REVIEW B VOLUME 29, NUMBER 4 15 FEBRUARY 1984

Quantum size effects on the plasma dispersion in quasi-two-dimensional electron systems

Sankar Das Sarma

PHYSICAL REVIEW B VOLUME 36, NUMBER 11 15 OCTOBER 1987-I

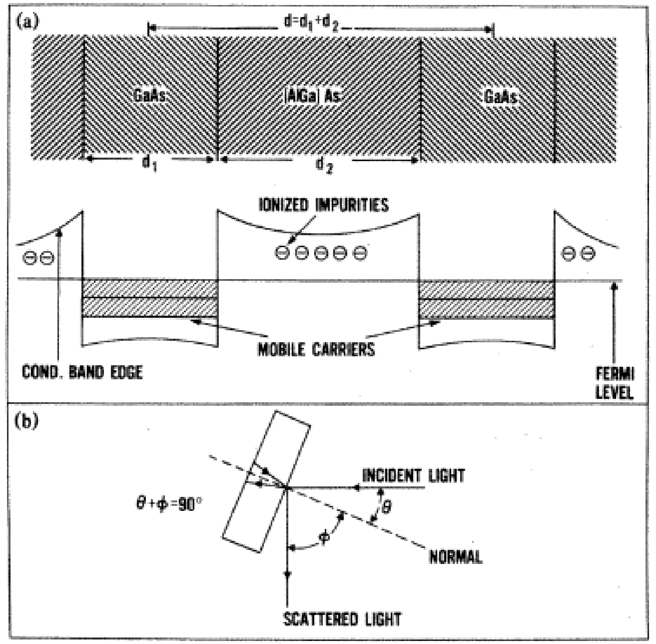
Elementary electronic excitations in a quasi-two-dimensional electron gas

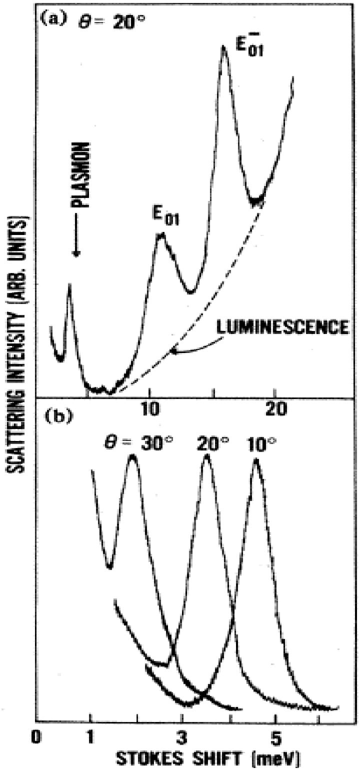
Jainendra K. Jain and S. Das Sarma

PHYSICAL REVIEW B VOLUME 26, NUMBER 2 15 JULY 1982

Plasma dispersion in a layered electron gas: A determination in GaAs-(AlGa)As heterostructures

Diego Olego and A. Pinczuk

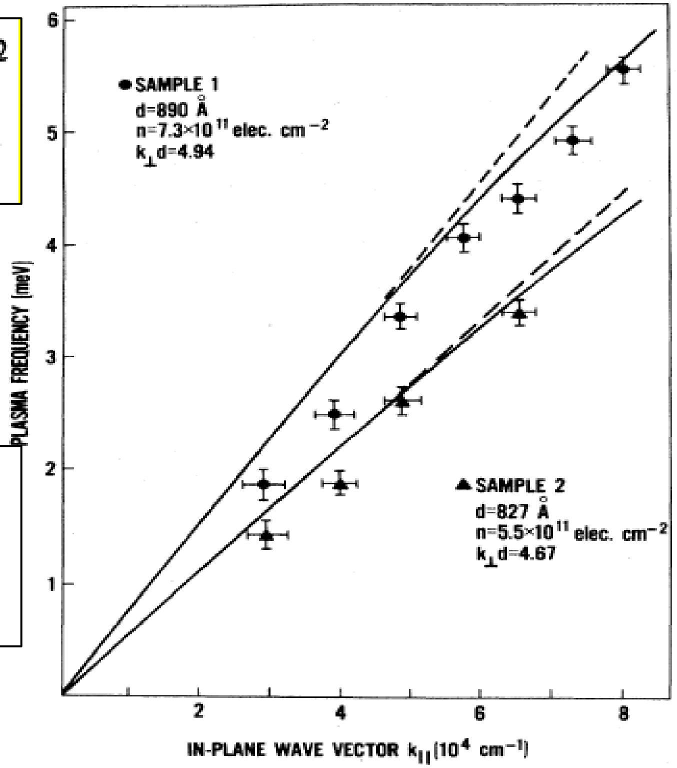


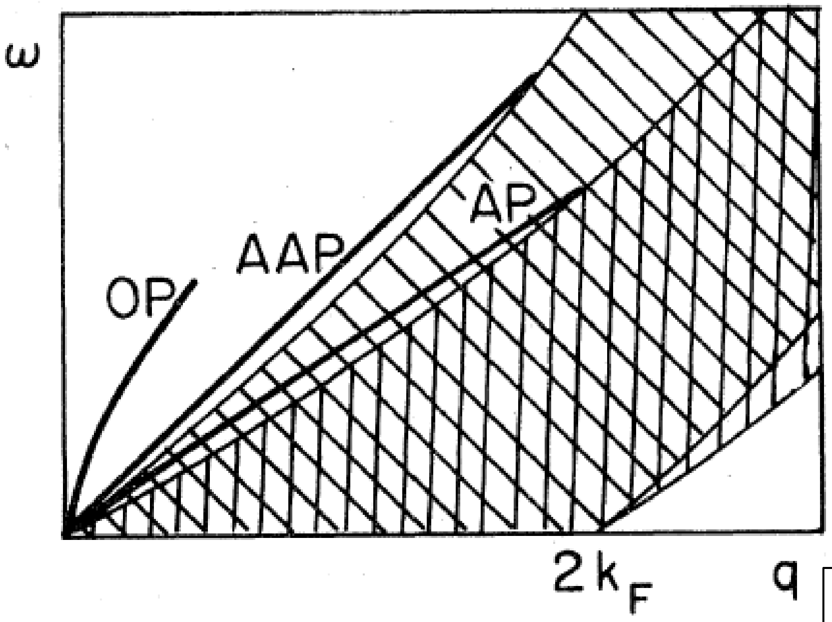


$$\omega_p = \left(\frac{2\pi n e^2}{\epsilon_M m^*} k_{\parallel} \frac{\sinh k_{\parallel} d}{\cosh k_{\parallel} d - \cos k_{\perp} d} \right)^{1/2}$$

$$(k_{\parallel} d << 1 \text{ and } k_{\perp} \neq 0)$$

$$\omega_p = k_{\parallel} \left(\frac{2\pi n e^2}{\epsilon_M m^*} \frac{d}{1 - \cos k_{\perp} d} \right)^{1/2}$$



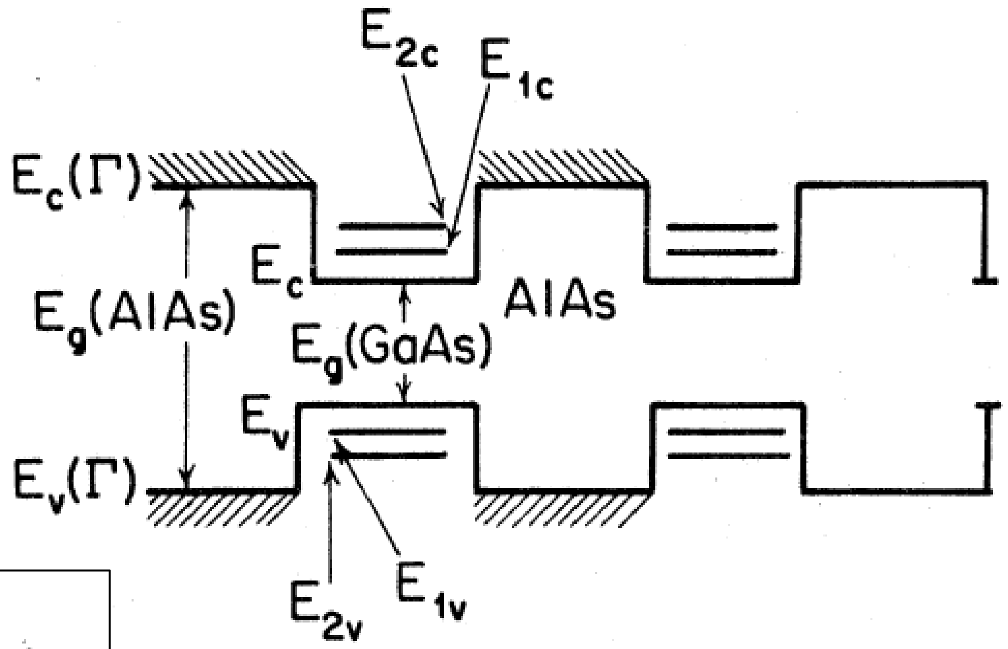


$$\omega_+ \simeq C_+ q^{1/2}$$

$$\omega_- \simeq C_- q\ .$$

$$\omega_A \simeq C_A q$$

PRB 23, 805 (1981)



$$|\epsilon| = |\delta_{ij} - V_{ij}(\vec{q})\Pi^0_{jj}(\vec{q},\omega)| = 0$$

$$C_A = \left(\frac{m_2}{2m_1} + Q_2 d\right)^{1/2} v_{f2}$$

$$V(q,z,z') = \pm\frac{2\pi e^2}{\bar{\kappa} q} e^{-q|z-z'|}$$

$$X_{ij} = (\epsilon^{-1}\Pi^0)_{ij}$$

$$S(\vec{k}, k_z; \omega) = 2\sum_{ijlm} \int dz \int dz'\, e^{-ik_z(z-z')}\xi_i^*(z)\xi_j(z)\xi_l^*(z')\xi_m(z')\,\mathrm{Im}X_{ijlm}(\vec{k},\omega),$$

$$1 = \frac{2\pi e^2}{\kappa q A}\Pi(q,\omega)\left[\frac{\sinh qa}{\cosh qa - \cos k_z a}\right]$$

PRB 25, 7603 (1982)

We first consider the $k_z \neq 0$ situation. Taking $qa \to 0$ limit of Eq. (40) gives

$$1 = \frac{2\pi e^2}{\kappa q A}\Pi(q,\omega)\left[\frac{qa}{1-\cos k_z a}\right]. \qquad (41)$$

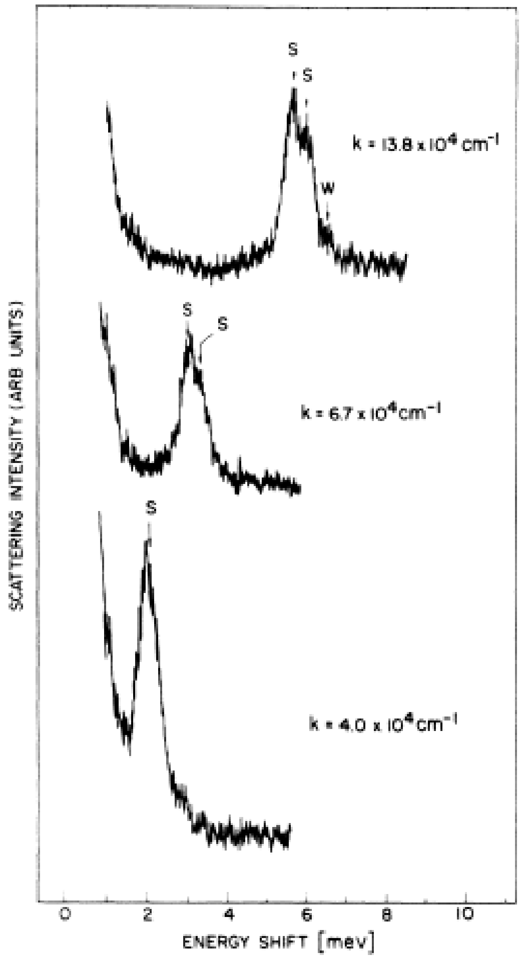
By using Eq. (30) for the long wavelength polarizability $\Pi(q,\omega)$, we obtain the following collective-excitation frequency in the long wavelength limit ($q \to 0$):

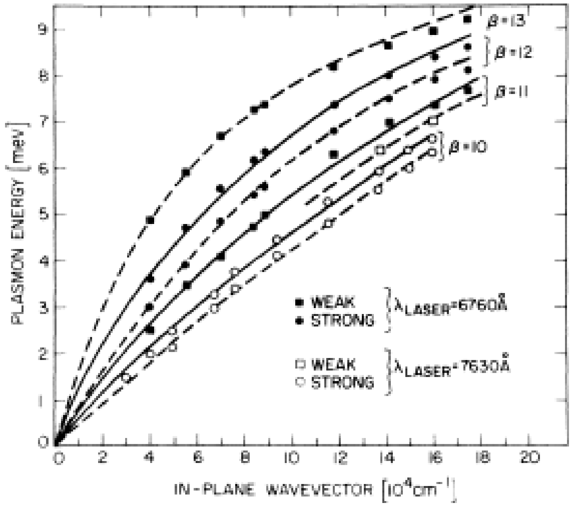
$$\omega \simeq \left[\frac{2\pi n_s e^2}{\kappa m}\right]^{1/2} (1-\cos k_z a)^{-1/2}\sqrt{a}\,q\ .$$

VOLUME 56, NUMBER 19 PHYSICAL REVIEW LETTERS 12 MAY 1986

Discrete Plasmons in Finite Semiconductor Multilayers

A. Pinczuk, M. G. Lamont, and A. C. Gossard
AT&T Bell Laboratories, Murray Hill, New Jersey 07974
(Received 19 November 1985)

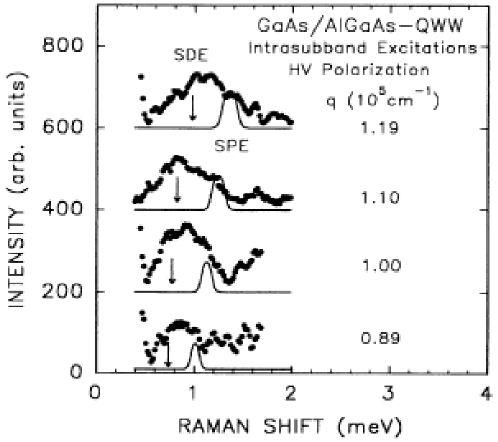


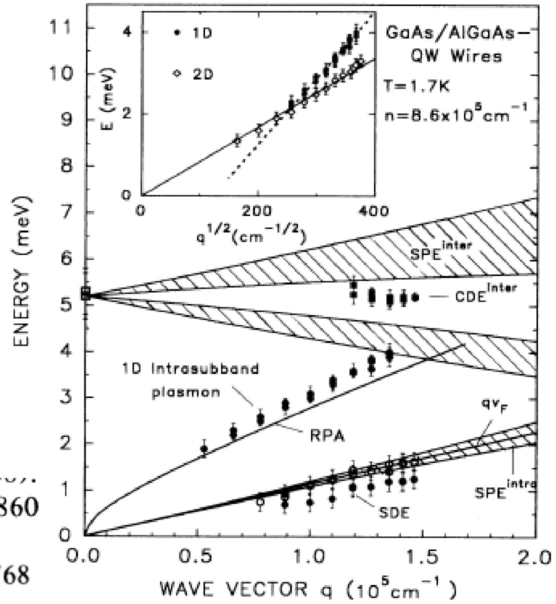


VOLUME 67, NUMBER 23 PHYSICAL REVIEW LETTERS 2 DECEMBER 1991

One-Dimensional Plasmon Dispersion and Dispersionless Intersubband Excitations in GaAs Quantum Wires

A. R. Goñi, A. Pinczuk, J. S. Weiner, J. M. Calleja,[a] B. S. Dennis, L. N. Pfeiffer, and K. W. West



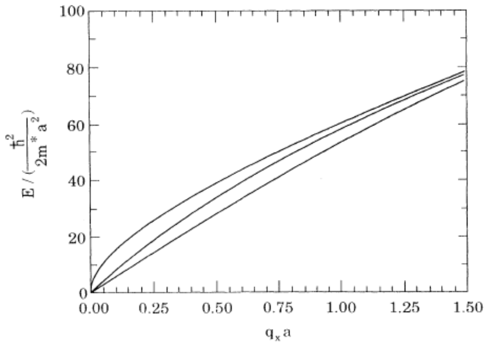


[9] Q. P. Li and S. Das Sarma, Phys. Rev. B **40**, 5860 (1989); **41**, 10 268 (1990).
[16] Q. P. Li and S. Das Sarma, Phys. Rev. B **43**, 11 768 (1991).

PHYSICAL REVIEW B VOLUME 43, NUMBER 14 15 MAY 1991-I

Elementary excitation spectrum of one-dimensional electron systems in confined semiconductor structures: Zero magnetic field

Q. P. Li* and S. Das Sarma

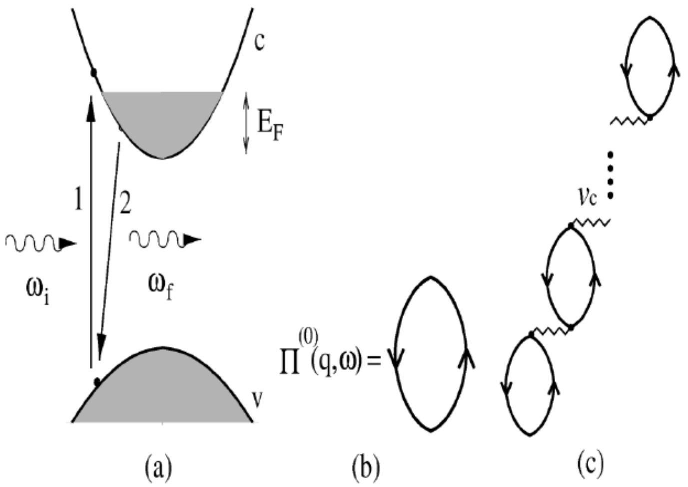


Why do SDE/SPE show up in the dynamical structure factor which should only measure the CDE/plasmon spectra in the reducible response?

Resonant Raman Scattering by Elementary Electronic Excitations in Semiconductor Structures

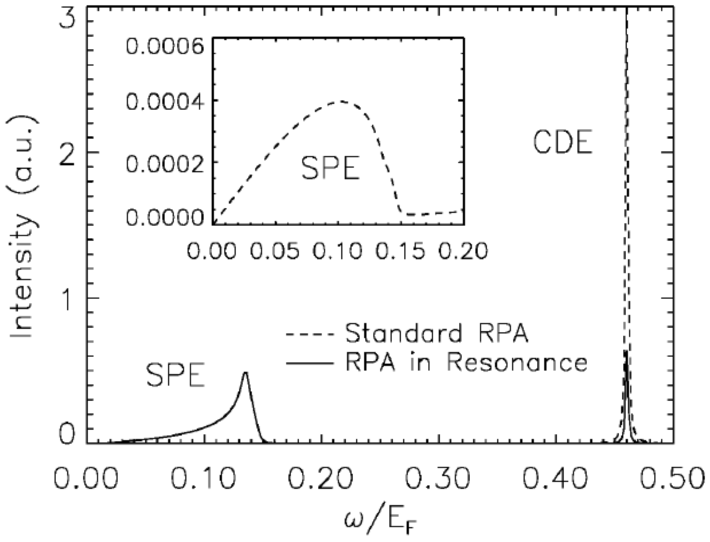
S. Das Sarma and Daw-Wei Wang

We explain quantitatively why resonant Raman scattering spectroscopy, an extensively used experimental tool in studying elementary electronic excitations in doped low-dimensional semiconductor nanostructures, always produces an observable peak at the so-called "single particle" excitation although the standard theory predicts that there should be no such single particle peak in the Raman spectra. We have thus resolved an experimental puzzle which dates back more than 25 years.



$$\frac{d^2\sigma}{d\Omega\, d\omega} \sim -\mathrm{Im}\left[\Pi^{(2)}(\mathbf{q},\omega) + \frac{[\Pi^{(1)}(\mathbf{q},\omega)]^2 v_c(\mathbf{q})}{\epsilon(\mathbf{q},\omega)} \right]$$

$$\Pi^{(n)}(\mathbf{q},\omega) = \frac{-2}{(2\pi)^D} \int d^D p \times \frac{[A(\mathbf{p},\mathbf{q})]^n\,[n_c(\mathbf{p}) - n_c(\mathbf{p}-\mathbf{q})]}{\omega + i\delta - E_c(\mathbf{p}) + E_c(\mathbf{p}-\mathbf{q})}$$



PHYSICAL REVIEW B, VOLUME 64, 165409

Plasmon dispersion in dilute two-dimensional electron systems: Quantum-classical and Wigner crystal–electron liquid crossover

E. H. Hwang and S. Das Sarma
Department of Physics, University of Maryland, College Park, Maryland 20742-4111
(Received 4 February 2001; published 5 October 2001)

We theoretically calculate the finite-wave-vector plasmon dispersion in a low-density two-dimensional (2D) electron layer taking into account finite temperature, finite layer width, and local-field corrections. We compare our theoretical results with recent Raman-scattering spectroscopic experimental 2D plasmon dispersion data in GaAs quantum wells at very low carrier densities ($r_s > 10$) and large wave vectors ($q \geqslant k_F$). We find good agreement with the experimental data, providing an explanation for why the experimentally measured dispersion seems to obey the simple classical long-wavelength 2D plasmon dispersion formula. We also provide a critical discussion on the observable manifestations of the quantum-classical *and* the Wigner crystal–electron liquid crossover behavior in the 2D plasmon properties as a function of electron density and temperature in GaAs quantum-well systems.

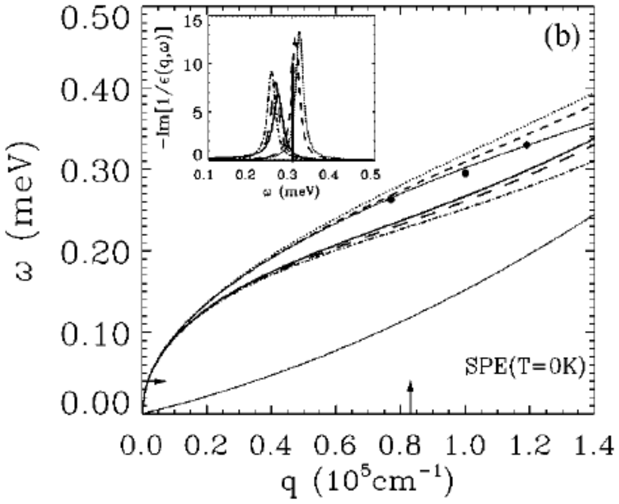


FIG. 1. Calculated plasmon dispersions with available experimental data (Ref. 11) for (a) $n = 1.2 \times 10^{10}$ cm^{-2} ($r_s = 5.3$) and (b) $n = 1.1 \times 10^{9}$ cm^{-2} ($r_s = 17.2$). Thin solid line is the classical local

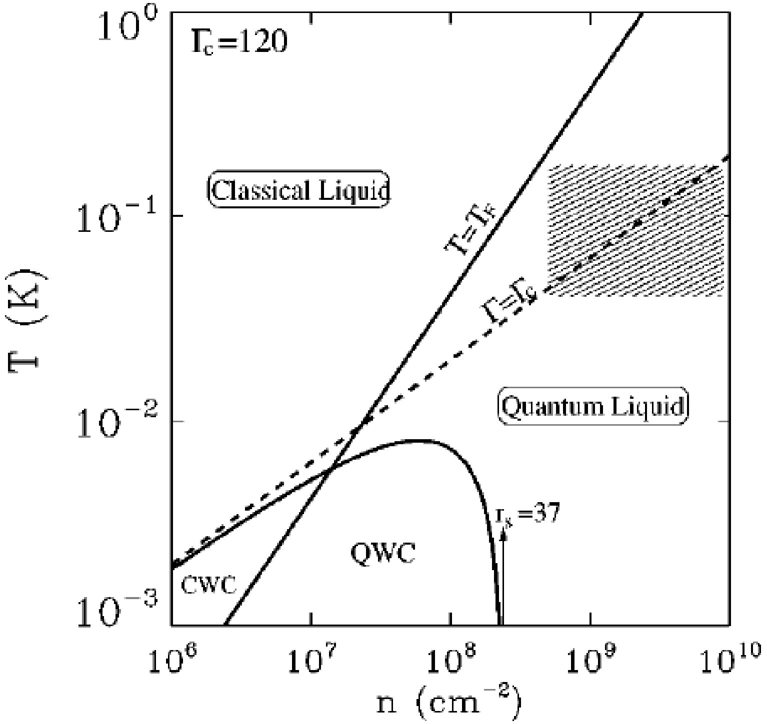
Most (all?) claimed 2D observations of WC are Anderson insulators, or at best Wigner glasses

VOLUME 82, NUMBER 10 PHYSICAL REVIEW LETTERS 8 MARCH 1999

Collective Excitations in the Dilute 2D Electron System

M. A. Eriksson,[1] A. Pinczuk,[1,2] B. S. Dennis,[1] S. H. Simon,[1] L. N. Pfeiffer,[1] and K. W. West[1]
[1]*Lucent Technologies, Bell Labs, Murray Hill, New Jersey 07974*
[2]*Departments of Physics and Applied Physics, Columbia University, New York, New York 10027*
(Received 22 October 1998)

Aron Pinczuk was my friend for 40 years



PRB Letter
Thermal melting of a quantum electron solid in the presence of strong disorder: Anderson localization versus the Wigner crystal
DinhDuy Vu and Sankar Das Sarma
Phys. Rev. B **106**, L121103 (2022) - Published 8 September 2022