Determination of nanotubes’ chirality and excitonic effect Before the NT07 conference takes place in Brazil in the year of 2007, one SWNT with unknown chirality will be touring many physics laboratories around the world and will be analyzed by as many ways as possible for the tried-and-true determination of its mysterious identity. But how can scientists possibly make it work? In Nagano NT06, A. Jorio, based on the photoluminescence (PL) and Resonance Raman Scattering maps, proposed to assign its chirality uniquely by measuring one RBM (radial breathing mode \( \omega \)) and resonant transition energies \( E_{ii} \). So here we have one isolated single wall nanotubes (either metal or semiconducting) and, we will know its \((n,m)\) by the following steps (if I understand right): (1) By resonant Raman spectroscopy to measure the RBM frequency, which is uniquely corresponding to the tube diameters \( d_i \) \((\omega x 1/d_i)\); (2) (However, some nanotubes with different chirality \((n,m)\) share the same diameters, for example \((n,m) = (6,5) \) and \((9,1)\).) So we measure the transition energies \( E_{ii} \) \( (i=1,2,3,4...) \) which take place between 1-d Van Hove peaks of electronic DOS under some symmetry considerations by the method of photoluminescence (PL) \((\text{one photon or more photons absorption})\); (3) Based on the 2 dimensional measurements above, we get diameter \( d_t \) and \( E_{ii} \) values for this nanotube, and refer them to the Kataura Plot for chirality. Work done! But there’re problems to be thought over. The original Kataura plot based on the simple tight-binding model \((\text{only orbital considered})\) is far from precise and unable to concern with the ratio problem and family spread problem, due to the deficiency of curvature, trigonal warping effect, and many body effects and so on. While the empirical Kataura plot based on experimental spectrofluorimetric study of 33 different nanotubes combined with careful fits is not so trustworthy either. And moreover it seems not certain whether working for bigger diameters. In Dr. Jorio’s talk, he deals with the questions in the higher transitional range and diameters. The semiconducting \( E_{33} \) and \( E_{44} \) can be firstly fit well with only considerations of curvature and trigonal warping effect, which hints a conventional band to band transition; while for \( E_{11} \) and \( E_{22} \) one more term has to be included in fitting, which as he suggested, exhibits the excitonic effect. Interestingly the calculated excition binding energies is simply inverse linear dependence on the diameters, from which the size of Mott-Wannier exciton may go smaller if size of nanotube shrinks, then I guess, the screening effect for electron-hole pair may become weaker and Frenkel exciton takes over. Therefore it’ll be very interesting to study excitonic splitting effects in smaller nanotubes.

Mesoscopic nGL \((n\text{-layer graphene film})\) and edge state in nanographene Low density of electrons and holes compensated with a very small effective mass or higher mobility renders the n-layer graphene film a newly and extensively studied system. Professor Peter C. Eklund, in his keynote talk, presented that Raman scattering is useful to characterize the number of layers of nGL, saying that the G bands and D bands will give out n-specific spectra. Philip Kim presented some results of nGL as thin as 12 nm about gate controlled transport and an experimental investigation of magneto-transport in single layer of graphene. The mobility is as high as 60,000 cm\(^2\)/Vs. For graphene with open edges, or graphene ribbon, Dr. Enoki mentioned the combination of Fujita’s and Klein’s edges brings about the completely localized edge state in the Fermi level and nano-magnetism. The controllable nano-scopic magnetism switch by gas adsorption may be used as gas sensor.

1d superconductivity It’s been reported that the C\(_{60}\) single crystal will get higher superconducting transition temperature if doped by Alkali metal like potassium or others, and this may be explained by the lattice expansion from the dopants, therefore increases the density of state around Fermi level and results in the increases of T\(_c\). And theory suggests that it’s even better if placing the fullerenes into nanotubes (peapods). Whether there’s still such a lattice expansion happening in peapods depends on the dopant sites (between peapods or within the peapods). Professor K. Suenaga from AIST presented visualization of ions trapped in side carbon nanospaces by means of HR-TEM and their results may encourage the realization of superconductor based on the nanotube peapods. Using the same method, he also presented fullerene derivatives insertion into nanotubes and got stronger interaction between fullerene and the nanotube wall. What’s interesting in prof. J. Haruyama’s presentation about superconductivity in entirely end-bonded MWNTs is the importance of the inter-shell effect appearing from the competition between superconductivity and Tomanagai-Luttinger Liquid (TLL) states. TLL states were suppressed by the inter-shell coupling due to incommensurate of chirality and Cooper-pair tunneling was allowed. Therefore T\(_c\) is enhanced as the number of walls and the strength of the inter-shell interaction.

CNTs as quantum dot In prof. C. Schonenberger’s talk, what interested me is the topic about studying the coexistence of competing Kondo effect and superconductivity in CNTs quantum dot. Kondo effect happens in the dilute anti-ferromagnetic materials with its local
magnetic moment screened by the conduction electrons. The spin singlet state will be stable and brings about the logarithmic dependence of resistivity on the temperature. But the cooper pair in the conventional superconductor is anti-aligned spin singlet and therefore will suppress Kondo effect. He did observe the suppression of conductance, but also see the enhancement in Kondo ridges with higher $T_k$. And he claimed that the energy for breaking a Cooper pair is less than that by the formation of the Kondo singlet, having binding energy of $K_B T_k$.

**people I talked with and others** I talked privately with Dr. G. Seifert about MoSI nanowire and his previous work on the Mo$_6$S$_x$ related cluster structure. I talked with Dr. Gunther Lientschnig from Hassanien Abdou’s group about my calculation results on MoSI nanowire and he shew interest in the magnetism appearing in one isomer and might want to testify it. And as a summary, I have experienced one of the most luxurious conferences that I have attended and got a lot of chances to learn what I could not from the papers. After Nagano NT06, I got a rough picture how the researches on Nanotubes have been and what more we will expect, and more importantly, achieved a bigger network of cooperation.

contact with yang@pa.msu.edu