INDIAN LATTICE GAUGE THEORY INITIATIVE

(ILGTI at DAE)

Networking of Indian Lattice Gauge Theorists in the Xth Five Year Plan, 2002–2007

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Why Lattice QCD ?

People & Current Activity

Physics of the Program

ILGTI - Idea and Strategy

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- Lattice QCD is a mature field which is now striving to obtain qualitative and quantitative predictions for future experiments in this area.

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- One of the seven 1M$ millennium problems is quark confinement and the existence of mass gap in Yang-Mills theory. See http://www.claymath.org.

People and LGT Activity

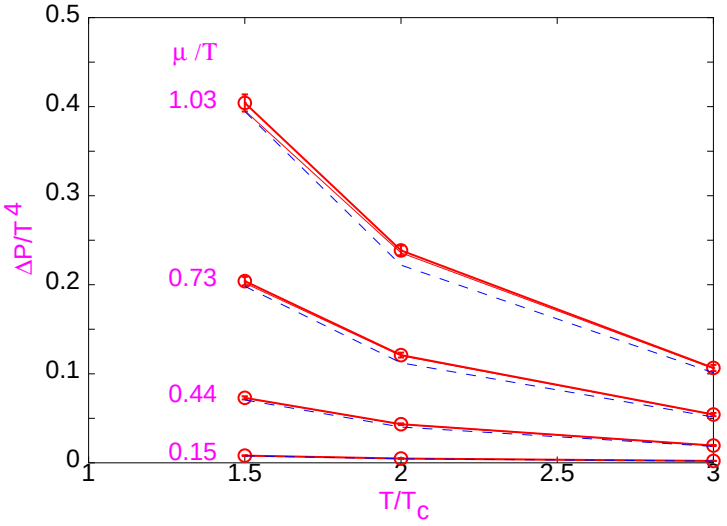
- R. V. Gavai and S. Gupta **(TIFR)**
- R. Anishetty, N. D. Hari Dass and H. S. Sharatchandra **(IMSc)**
- A. K. De, A. Harindranath and P. Mitra **(SINP)**
- S. Naik **(HRI)**
- M. Mathur **(SNBCBS)**

Indian LGT Activity:

- $T \neq 0$ Lattice QCD @ TIFR, IMSc, SINP $\longrightarrow$ the experimental search for QGP.
- topological excitations @ IMSc, SNBNCBS, TIFR $\longrightarrow$ confinement.
- lattice perturbative QCD @ HRI, TIFR $\longrightarrow$ Improved Actions, Operators.
- chiral gauge theories @ SINP $\longrightarrow$ the electroweak physics.

Physics of the Program

- Strangeness Enhancement – Gavai&Gupta, PRD 2002 (S. Gupta's talk)
- Equation of State – Gavai & Gupta, PRD 2003



- Velocity of Sound in QGP – in progress with IMSc

ILGTI- Idea & Strategy

- A variety of physics problems which need varying levels of approximations and computer power. Exploration of new ideas done in simplest approximation but full theory simulations essential for realistic predictions.

- Computationally intensive part of full QCD simulations can be reduced to computing inverse of a matrix of typical size $10^6 \times 10^6$. Typically, one needs to do this a few lakh times. Mostly in a sequential manner since results of one inverse computation determine the next matrix.

- Sequential nature common to simpler approximations as well. Tightly knit computation and communication cycles must for multiprocessor systems.

- Choice of hardware : Many technological options with varying advantages which span a range of CPUs from supercomputers to workstation clusters to PC clusters.

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- Choice of hardware : Many technological options with varying advantages which span a range of CPUs from supercomputers to workstation clusters to PC clusters.

- Appropriate software : debugging, tuning to extract maximal sustained speed.

- True parallel processing since all CPUs are involved in a single matrix inversion: fast communication network amongst processors crucial.

- Parallel processing usually optimally utilised when problem size is scaled with number of processors. However, for a fixed problem size one generally gets efficiency $\leq 50\%$.

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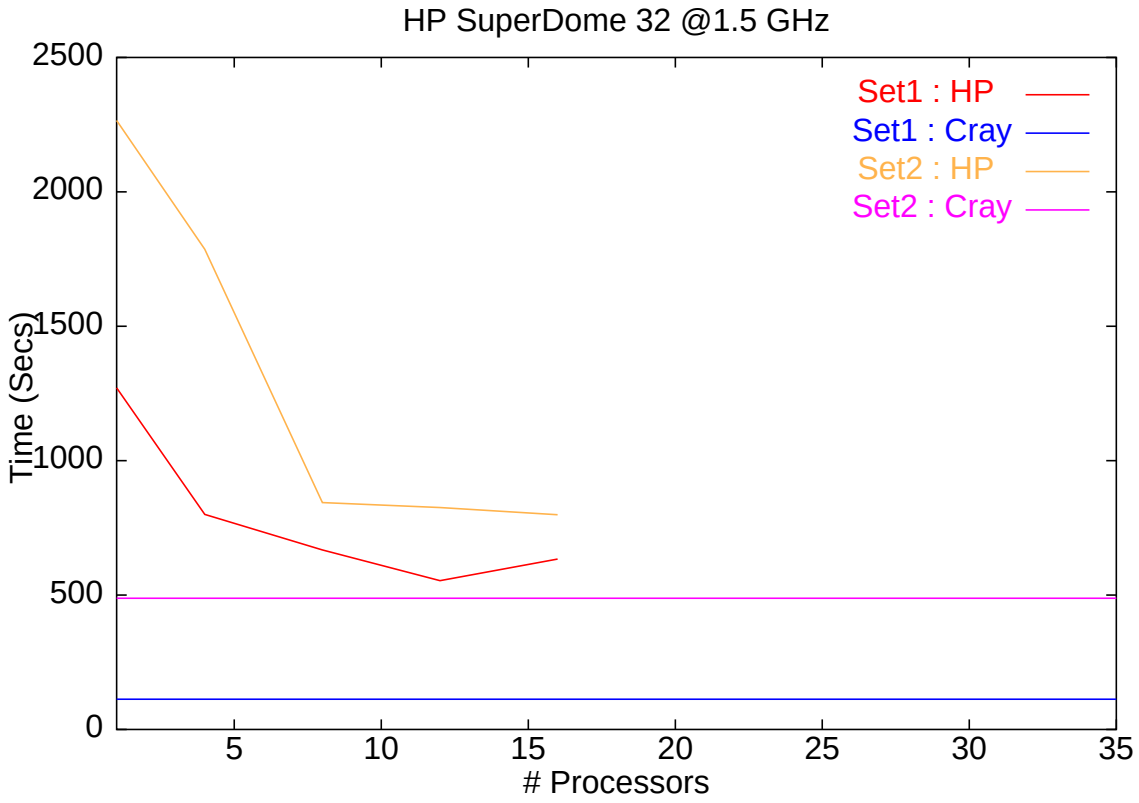
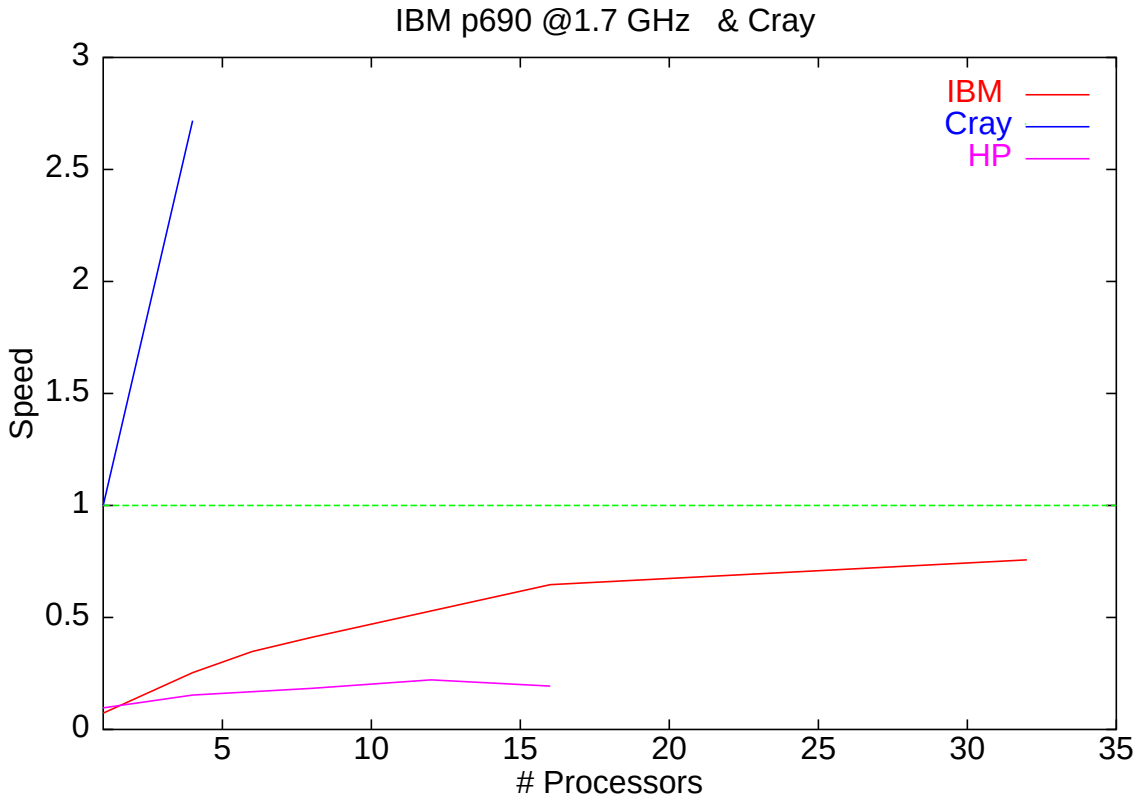
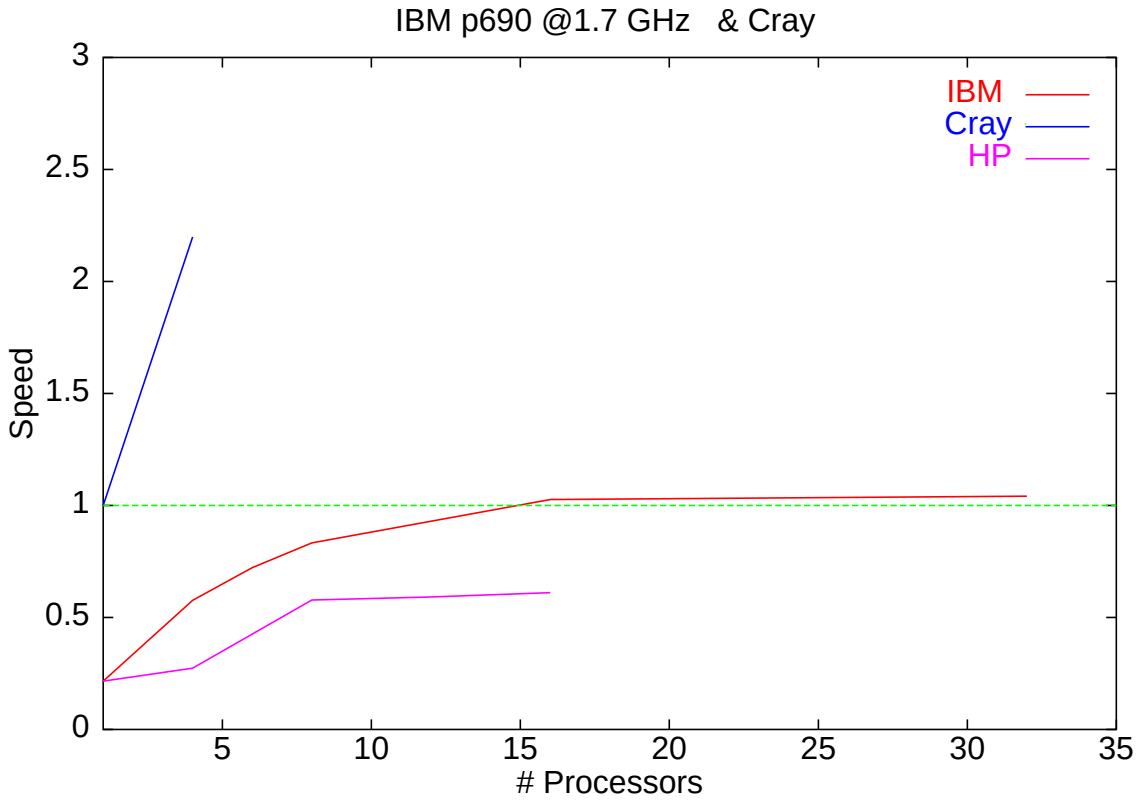
Hybrid Monte Carlo – Full QCD Sets 1 & 2



Hybrid Monte Carlo – Full QCD Set1



Hybrid Monte Carlo – Full QCD Set2



ILGTI Joint Strategy

- Although Cray is the winner today, advances in processor and communication technology may alter the scenario in future.

- Try different options in different institutes and share all the resources amongst us:
  - Joint collaborations (Already begun).
  - Sharing of stored configurations for studying different physics aspects.
  - Evaluate new ideas in quenched QCD on clusters.
  - Optimize use of resources by scheduling exploratory work and large projects wisely.

- Develop better algorithms and programs which can exploit the parallelism of the machines better. This may need total reworking of the method and rewriting of the program.

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By the end of Xth plan,

- Joint large research projects of relevance to heavy ion program.
- Several individual projects exploring new ideas.
- Ready to take on more complex problems like CP violation (hadronic matrix elements), dilepton production etc.

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