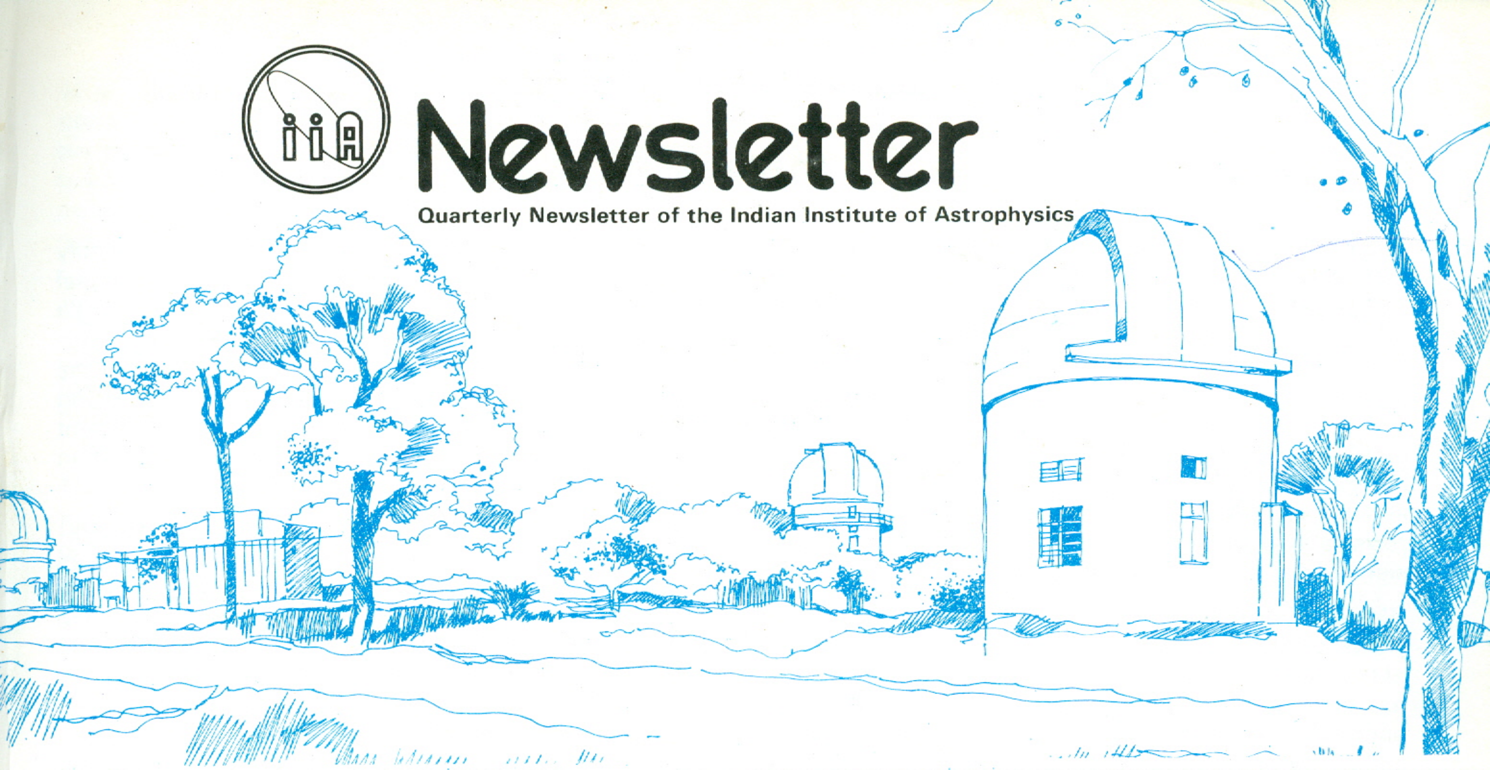

Newsletter

Quarterly Newsletter of the Indian Institute of Astrophysics

Volume 3 | Number 4 | October 1988

New Computer System at Bangalore Campus

We have acquired for the Bangalore campus a powerful 32-bit super-minicomputer MIGHTY FRAME II (MF II) which can support upto 64 concurrent users. This is manufactured by Convergent Technologies Inc, USA—who are well known as an O.E.M. (Original Equipment Manufacturers) company—and marketed by UPTRON India Ltd. The main CPU works with 68020 Motorola chip operating at 25 MHz and 128 Kb cache. To speed up the mathematical operations, MC 68881 floating-point processor is added to it. 8-Mb ECC RAM is at present the main memory. Two winchestor disk units with capacities 85 Mb and 280 Mb are also available. SCSI bus adapter working at 4 Mb/sec is in the I/O channel. 60-Mb capacity cartridge tape drive is also accommodated in the main cabinet itself. The CPU works at 5 MIPS rating. MF II is one of the latest state-of-the-art computer systems.

CTIX, the operating system for the Mighty Frame series is derived from the industry standard UNIX system V. At present we have FORTRAN 77 and C compilers. One of the main attractions of this computer is its small physical dimensions: height 74 cm, width 29 cm, depth 66 cm and weight 64 kg. This main cabinet houses CPU, memory boards, 3 disk drives giving over a giga byte of storage, and a cartridge tape drive. It occupies very little space and the power consumption is less than 3 KVA. The demand on air-conditioning requirements is also consequently less. The system has provision for memory and I/O expansion.

We have got four CT 220-type terminals, three personal computers (PCs) each with two floppy drives and one PC XT plus with a 20 Mb winchestor disc, a floppy drive and a colour chrome monitor, one Godrej printer (144×240 dpi) working upto a speed of 300 cps, all connected to the MF II computer. The printer has both parallel and serial ports and is attached to the PC XT plus also. In emulation modes it can work as EPSON MX 80, GRAFTRAX or ANADEX DP-9600 printers. File transfer utility through the PCs from the floppy diskettes to MF II and vice versa is available.

The capabilities of MF II are equivalent to that of VAX 8600, both in CPU power and in the various disk and I/O operations to support the level of processing. However, the price of MF II is about one seventh of that of VAX 8600 (see *Computer Age*, February–March 1988, p. 28).

The installation of MF II was completed in the first week of June and a training programme was given to all the users for a fortnight by UPTRON company. This was attended by IIA staff and a few research scholars from Bangalore University. Now the system is in regular usage for scientific purposes and there is a lot of demand for terminal and computer time. A spooler-type tape drive, augmentation of the memory to 16 Mb are all on the cards. We are planning to equip the new computer centre with a graphics package, a VT 240–type terminal and a suitable letter-quality printer/plotter. With these facilities we will be in a position to type scientific papers and also prepare graphs and tables for publication purposes.

K. E. Rangarajan

Quarks in Mini Bangs

Bhaskar Datta

The present-day accepted understanding of the fundamental structure of all matter is in terms of quarks and leptons (such as electrons, muons and neutrinos). The interactions between quarks is mediated by the exchange of photon-like particles called gluons. If the hot big bang model of cosmology is correct, then the early universe must have evolved through a phase made up of quark-gluon plasma (QGP). This has important implications for primordial nucleosynthesis, galaxy formation and the dark matter problem. So, a basic question in physics in recent times has been: are there any 'good' signatures for the evidence of quarks?

With very recent CERN experiments (Gutbrod 1988), yielding eminently suitable data for possible candidates of the QGP, the search for appropriate signals for quarks has reached a new level of ingenuity, although deciphering the signals of the QGP from the associated pollutants of the hot hadronic matter still remains the central issue. Whether the initial QGP, if at all formed, can be described in thermodynamic language is yet another issue of considerable uncertainty. The contemporary consensus is that a quark-gluon system, formed in the initial times immediately after collisions of nuclei at ultrarelativistic energies, expands and cools to a mixed phase of hot hadronic matter, quarks and gluons, eventually "freezing", to a system of non-interacting hadrons. Thus, the space-time evolution of the system is an all-important deciding factor. Most of the recent works on QGP signals depend tacitly on the applicability of local thermodynamic equilibrium—Landau type hydrodynamics in particular.

Muon pairs and photon pairs have the unique property of interacting weakly and electromagnetically, respectively, thus being somewhat more efficient in retaining the initial memory of the QGP. Rather recently, it was pointed out that photon pairs can be a very useful signal of QGP since the production rate of photon pairs for the quarks and gluons is at least an order of magnitude higher than the corresponding rate from the hadronic matter, in contrast to the muon pairs (Yoshida, Miyazaki & Kadoya 1987). The muon pairs do not seem to attain a significant rise of production rate for the QGP compared to the hadronic world. The observation however ignores the space-time evolution of the plasma. More recently, Redlich (1987) pointed out that the above observation is not tenable once the space-time evolution is taken into account, and concluded that the muon pairs still remain at least qualitatively a better candidate for detecting QGP.

We have examined (Datta, Raha & Sinha 1988) these claims in detail and wish to point out that (a) the transverse momentum (P_T) window does happen to play a deciding role, and (b) the ratio, gamma to muon pairs, is probably the most efficient signal of QGP, saturating to a constant value beyond a certain invariant mass, much like a snapshot of the formation of the QGP. The saturating property of the ratio remains remarkably insensitive to P_T. The universality of such a signal (Sinha 1986) for the complementary case of the single photon to dimuon pairs attains a degree of self-consistency for the present case—the invariant mass of the photon pairs (in contrast to a single photon) being identical to that of the muon pairs, acts as an efficient and unambiguous kinematic variable, measurable in experiments.

We assume that at an initial proper time τ_0 and temperature T_0, the system is in thermodynamic equilibrium state of quarks and gluons, which cools to a mixed phase of hadronic matter in thermal equilibrium with the QGP, in a first order phase transition, as the temperature reaches a predefined critical temperature T_c ($\simeq$ 200 MeV). Evolving isentropically, the plasma retains the total entropy up to the final state of non-interacting hadrons, leptons and photons, the freezeout being defined by a final temperature T_f, usually taken to be the pionic mass ($\simeq$ 140 MeV).

The hydrodynamical evolution of the system can be understood in terms of a superposition of two elementary motions, a uniform longitudinal motion and a transverse rarefaction. With the space-time evolution of the system, as a result of both longitudinal and tranverse expansions, it will eventually undergo a first order phase transition from the QGP to the hadrons. In our analysis the central characteristic is a transition within a very small temperature interval without invoking any violent scenarios. With isentropic expansion the various scenarios of the system, as it evolves from the quark at the initial time to a mixed phase and eventually to pure hadrons, is decided by the entropy of the system at a proper time τ, the entropy window guiding the evolution from one phase to the other.

For an isentropic expansion, an "entropy" window penetrates throughout the space-time evolution of the system, allowing one to connect primeval particle production rates with the observed final state of the collision. One immediately finds that for very early times, the entropy is large corresponding to a state of QGP. At this state of the evolution of the system, the transverse motion is yet to set in; the longitudinal motion essentially determines the evolution satisfying, in general, invariance under a Lorentz boost. Thus, to look for signals of QGP, the appropriate kinematic window will be large invariant mass (M), corresponding to early times. This domain is also simultaneously characterised by low hydrodynamic P_T (because of predominantly longitudinal motion) which, however, may partly be compensated by the P_T due to high temperature.

This observation is strictly for isentropic expansion associated with a first order phase transition, neglecting nonequilibrium direct partonic contribution to dimuon pairs. For a first order phase transition, there exists a long-lived intermediate region where both phases coexist at the same temperature, corresponding to a broad overlap region, such that photon pairs and/or dimuons are produced with M between $5\,T_c$ and $15\,T_c$ either in quark-gluon phase and/or in the hadronic phase with no distinct separation of the signals. The QGP dominates above $M \geqslant 10\,T_c$ (~ 2 GeV) and for $M \leqslant 5\,T_c$ (~ 1 GeV), the hadron phase dominates. In contrast, for second order phase transition, the transition is instantaneous with a very narrow overlap region. For dimuons, however, the non-QGP contribution in the form of Drell-Yan phenomenon shows up for large M, thus making the signals from a pure QGP polluted by Drell-Yan dimuons.

The ratio (R) of dimuon to diphoton production rates has some remarkable properties (Sinha 1986), rendering it an excellent candidate for the detection of QGP. Beyond a certain invariant mass, the ratio tends to saturate, signalling the onset of QGP, rather like a snapshot. Further, the ratio turns somewhat insensitive to the initial conditions T_0 and τ_0 and associated uncertainties (such as initial entropy).

For transverse momentum 0.2 GeV $\leqslant P_T \leqslant$ 2.0 GeV and large invariant mass $M \geqslant 2.0$ GeV, we find a kinematic window ideally suited for detection of QGP both for muon pairs as well as photon pairs. For $P_T \geqslant 2.0$ GeV, the photon pairs appear to have an added advantage for reasonable invariant mass (~ 2.0 GeV); for even larger transverse momentum, the signals from QGP get washed away, the fluid primarily consisting of the hadrons experiencing a transverse motion collectively. The ratio R is an excellent snapshot of the onset of the QGP. At or around $M \geqslant 2.0$ GeV the ratio saturates, signalling the QGP. At small M, the predominant production channel from the ρ-meson acts as an excellent precursor for the detection of the phase transition. It should be emphasized that the numbers quoted above refer to the canonical $T_c \simeq 0.2$ GeV and may be appropriately scaled, should one prefer a different value of T_c.

References

Datta, B., Raha, S. & Sinha, B. (1988) *Nuclear Phys. A* (in press).
Gutbrod, H. (1988) Invited talk at International Conference on *Physics & Astrophysics of Quark-Gluon Plasma*, Bombay, Feb 8–12.
Redlich, K. (1987) *Phys. Rev. D.* **36**, 3378.
Sinha, B. (1986) *Nuclear Phys. A* **459**, 717.
Yoshida, R., Miyazaki, T. & Kadoya, M. (1987) *Phys. Rev. D.* **35**, 388.

newsline

K. R. Sivaraman is serving as the Chairman of INCA (Indian National Committee for Astronomy) of Indian National Science Academy for a three-year term from August 1988. He has also been nominated as a member of the ADCOS (Advisory Committee on Space Research) to the Department of Space from August 1988.

* * *

The essay titled "Supermembrane defects in the early universe" by C. Sivaram received honourable mention at the 1988 essay competition of Gravity Research Foundation. He was also a visiting Professor at the Universities of Bologna and Ferrara (1988 March–June) and visiting scientist, CERN and ICTP (1988 July–August).

* * *

The following members of the staff attended the XX General Assembly of the IAU at Baltimore and the attendant commission meetings during 1988 August 1–11:

K. S. Balasubramaniam, H. C. Bhatt, J. C. Bhattacharyya, M. H. Gokhale, S. K. Jain, N. Kameswara Rao, V. Krishan, M. Parthasarathy, A. K. Pati, R. Rajamohan, A. K. Saxena, K. K. Scaria, K. R. Sivaraman, A. Vagiswari.

* * *

International symposia, colloquia, workshops and conferences attended by members of the staff:

H. C. Bhat and S. K. Jain: IAU Symp. 135: *Interstellar Dust* (California, 1988 July)
J. C. Bhattacharyya: IAU Coll. 112: *Light Pollution, Radio Interference and Space Debris* (Washington, 1988 August)
N. Kameswara Rao and M. Parthasarathy: IAU Coll. 106: *Evolution of Peculiar Red Giant Stars* (Indiana, 1988 July)
R. K. Kochhar: NATO Advanced Study Institute: *Evolutionary Phenomena in Galaxies* (Puerto de Cruz, 1988 July)
V. Krishan: IAU Symp. 104: *Solar and Stellar Flares* (Stanford, 1988 August)
P. K. Raju: 27th meeting of COSPAR (Espoo, 1988 July)
C. Sivaram: ESO-CERN Symp: *Cosmology, Astrophysics and Fundamental Physics. Cosmology in Retrospective.* (both 1988 May). ICTP Workshop: *High Energy Astrophysics and Cosmology.* ICTP Conf.: *Phenomenology in Particle Physics* (1988 July–August).
K. R. Sivaraman: 10th Sacramento Peak Summer Workshop: *High Spatial Resolution Solar Observations* (1988 August).
A. Vagiswari: IAU Coll. 110: *Library and Information Services in Astronomy* (Washington, 1988 July–August)

of human elements

A ground-based observation

Astronomy produces more heroes than the fields of battle. One of them was certainly Hiram Mills Perkins, the magnificent old teacher who made the Perkins Observatory, at Delaware, Ohio, a possibility. He taught geometry, among other things, and for three successive days asked a student named Starr to demonstrate a proposition at the blackboard. Thrice unprepared, the student must have at last decided that he would have to weaken, and on the fourth day it was obvious to Prof. Perkins that the boy was confident. When his turn came, Prof. Perkins turned to him and quietly remarked, "Now, Starr, scintillate!"

Sky & Telescope (1942), 1, No. 5, p. 21

out of context

. . . it is instructive to follow Hamada and Salpeter and see how their structure is related to that of white dwarfs.

The Physical Universe p. 425

* * * *

. . . Strong sources, with $R \geqslant 50$, compromise about 15% of each sample.

Astrophys. J. (1981) **245**, 25.

* * * *

. . . can be explained as a result of anonymously low temperature achieved in this supernova . . .

Space Sci. Reviews (1988) **46**, 247.

Editors: T. P. Prabhu & A. K. Pati
Editorial Assistant: Sandra Rajiva
Published by the Editors on behalf of the Director, Indian Institute of Astrophysics, Bangalore 560 034.

Newsletter
Quarterly Newsletter of the Indian Institute of Astrophysics
Vol. 3, No. 4, October 1988.

To:

Indian Institute of Astrophysics
Bangalore 560 034.