Moreover, 6 flashes visible on two frames have been detected. These are unlikely to be satellite images, because staying on 2 frames in a single pixel requires very high orbit, which contradicts their high brightness. However, no coincidence with any satellite GRB trigger was detected. One flash was visible on more than 2 frames and turned out to be a CN Leo flare star outburst (Fig. 2). Example of a slower flare found off-line is shown in (Fig. 3). Those examples prove that the apparatus is indeed capable of detection of optical flashes of cosmic origin.

The project is conducted in collaboration with Center of Theoretical Physics PAS in Warsaw, Warsaw University and Warsaw University of Technology.

[1] A.Burd et al., "π of the Sky" - all-sky, real-time search for fast optical transients, astro-ph/0411456, to be published in the New Astronomy
[2] B.Zhang and P.Meszaros, astro-ph/0311321
[3] B.Paczyński, astro-ph/0108522
[4] GCN Circulars: 2677, 2725, 2862, 2970, http://gcn.gsfc.nasa.gov/gcn3_archive.htm

*) for "π of the Sky" Collaboration, http://grb.fuw.edu.pl

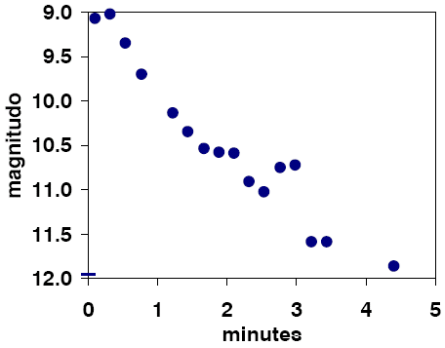

Fig. 2 Outburst of CN Leo flare star automaticaly detected 2005.04.02. The star brightness increased 100 times.

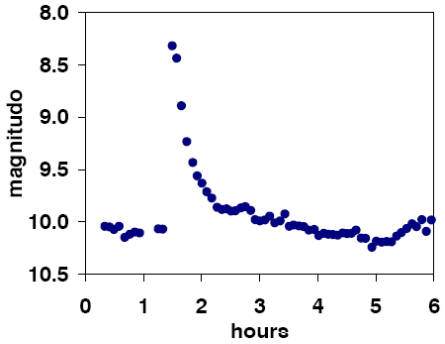

Fig. 3 Outburst of EQ Peg flare star of 2004.09.19.

6.16 Transport Theory Beyond Binary Collisions

by St.Mrówczyński

Transport theory is a very convenient tool to study many-body nonequilibrium systems, both relativistic and nonrelativistic. The kinetic equations, which play a central role in the transport approach, usually assume that dissipation processes are governed by binary collisions. However, when the system of interest is very dense one expects that multi-particle interactions will play a significant role. Furthermore, in relativistic systems a characteristic particle's energy is usually comparable to the particle's mass, and processes leading to particle production become important. It is thus expected that multi-particle interactions and production processes play an important role in the dynamics of quark-gluon plasma which is usually both relativistic and dense. The form of relativistic transport equation, which includes the multi-particle processes, was postulated by some authors, but the first systematic derivation was given in [1].

The self-interacting scalar fields with cubic and quartic interaction terms were studied and the Schwinger-Keldysh formulation of quantum field theory was used. There were basically two separate parts of the study [1]. The first part was the derivation of the general structure of the transport equations, and the main steps of the derivation were the following. The so-called contour Green's function, which satisfies the Dyson-Schwinger equations, was defined. The Wigner transformation and a gradient expansion were performed by assuming that the system was macroscopically quasi-homogeneous. The resulting pair of equations of motion was converted into the transport and mass-shell equations. The distribution function of usual probabilistic interpretation was defined, and the transport equation satisfied by this function was found. The equation was derived to lowest order in the gradient expansion corresponding to the Markovian limit.

In the second part of the study [1], a perturbative analysis of the self-energies, which enter the transport equation, was performed. The Vlasov or mean-field terms were shown to be dominated by the lowest order tadpole diagrams, while binary collisions emerged from two-loop contributions. The multi-particle interactions and production processes appeared at three-loop level in the φ^3 model and at four-loops in the φ^4 Using the MATEMATICA program to compute a large number of graphs, the collision terms, which correspond to the $2 \leftrightarrow 3$ processes in φ^3 model and the $2 \leftrightarrow 4$ and $3 \leftrightarrow 3$ processes in φ^4 model, were found. Validity of the results was discussed in detail.

[1] M.E.Carrington and St.Mrówczyński, Phys. Rev. D 71 (2005) 065007