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Image analysis of astronomical data

Mikio Morii
The Institute of Statistical Mathematics, Japan

We present our recent works on astronomical image data analysis.

(1) As Satoru Katsuda presented in this meeting, the mechanism of neutron star kick is now solved as hydrodynamic kick model rather than conflicting neutrino-induced kick model by our evidence of anti-correlation of supernova ejecta against kicked neutron star. For this study, we proposed an image decomposition method for each energy spectral component. Here, we changed the cost function of maximization from the likelihood to chi-squared gamma function, and used quadratic programming for the optimization, instead of using Xspec.

(2) A supernova remnant Cas A is expanding until its explosion at about 350 years ago. Chandra X-ray telescope has been monitoring its expansion for more than 10 years and captured the expanding ejecta. We proposed to use optical flow method to visualize such moving regions in Cas A images. We clarified the velocity map of ejecta and found that inward moving regions correspond to synchrotron emitting regions with the bright hard X-ray emission observed by NuSTAR telescope.

(3) Optical wide-field sky surveys with a high cadence have created a new field of astronomy, "movie astronomy." One of such survey is Tomo-e Gozen, which surveys all the sky by taking image data in 2Hz with a wide field of view of 20 square degrees. But, the amount of data will be huge (~30TB per a night), and hence efficient data compression is necessary. We proposed a low-rank matrix approximation with sparse matrix decomposition as a promising solution. The data can be compressed by a factor of about 10 in size without losing transient events.

morii@ism.ac.jp