Wide-Field Electronographic Camera with the Imaging Plate as a Detector: Call for the Test of the Imaging Plate

The purpose of this paper is to point out that an electronographic camera in which the photostimulable phosphor (Imaging Plate) is used as a detector is possibly a new tool for wide-field imaging.

The imaging plate developed by Fuji Film Co. is a film coated with the photostimulable phosphor ($BaFBr:Eu^{2+}$) (Amemiya & Miyahara 1988; Amemiya et al. 1988). When X-rays, or electrons expose the imaging plate, the absorbed incident energy is temporarily stored in the form of quasi-stable colour centres; when later stimulated by a scanning He-Ne laser beam ($\lambda \sim 632.8$ nm), the imaging plate emits photostimulated luminescence ($\lambda \sim 390$ nm) with an intensity proportional to the absorbed energy, which can be measured with photomultiplier tubes. High-resolution imaging-plate readers with pixel sizes of 25 x 25, 50 x 50, and 100 x 100 μm^2 have been developed, of which the scanning speed is ~ 14 μs per pixel (Amemiya et al. 1988; Mori et al. 1990). The imaging plate is also repeatably usable. Irradiation with white light completely erases the residual image on the imaging plate. It is therefore possible to read the imaging plate through a glass window from outside the camera within which the imaging plate is moved between the focusing plane and the readout glass window.

The imaging plates are now widely used in the fields of medical radiography, X-ray diffraction experiments (Amemiya et al. 1988), transmission electron microscopy (Mori et al. 1990), and so on. These experiments reveal superior imaging capabilities of the imaging plates for the detective quantum efficiency, dynamic range, linearity, uniformity, storage capacity, and format size. The dynamic range of $\sim 1:10^5$ and large format size (the size of 35 x 43 cm is available) are of particular interest for wide-field imaging astronomy.

Since the imaging plate has no sensitivity in visible light, the imaging plate has to be exposed to accelerated electrons (~ 10-50 keV) within an electronographic camera. Until about a last decade, various types of electronographic cameras had been developed to realize both high sensitivity and large format. The Lallemand camera with an 81 mm field in diameter was successfully developed by the Paris Observatory (Lallemand et al. 1970; Wlérick et al. 1984; Servan et al. 1985). The 5-cm Mark II camera with the barrier membrance was built and routinely used by the McDonald Observatory (Griboval 1979a, b), and the 9 cm Mark III camera was tested (Jia & Griboval 1985). Holm & Griboval (1986) described the design of a 9 cm Mark IV camera. McMullan (1972) also described the design of an 8 cm I.N.T. prime focus camera.

However, development of such large format electronographic cameras has been abandoned because of the availability of CCDs. Alternatively, development of mosaic CCD cameras are now in progress. Nevertheless, wide-field astronomy demands a detector size much larger than the biggest CCD chip or reasonable mosaics of CCDs. A 20-50 cm field in diameter is required by Schmidt telescopes, Ritchey-Chrétien telescopes for sky surveys, astrographs, and patrol cameras.

As mentioned by Griboval (1979a), there are no technical problems in producing electronographic cameras with a 20 cm field in diameter. Development of cameras larger than this may require a uniform focusing magnetic field much better than that of the focusing magnet or coil. Such a highly uniform magnetic field can be provided by a superconducting solenoid (Carruthers 1979). Furthermore, its strong magnetic field enables us to use a non-flat photocathode matching to the focal surface of a Schmidt or Ritchey-Chrétien telescope. New techniques of superconducting magnet and matching curved photocathode being adopted, it seems feasible to develop an electronographic camera with a ~ 30 cm field in diameter.

The imaging-plate electronographic camera (IPEC) proposed here is supposed to have the following characteristics:

1) the IPEC is a wide-field imaging device, whose detective quantum efficiency is comparable with photocathode-based detectors. The IPEC may also provide excellent imaging capabilities in the UV;

2) the IPEC is an intensifier device. Acceleration of photoelectrons reduces the effect of CR events;
3) the dynamic range is very high, ~ $1:10^5$, which is not the limit of the imaging plates but the limit of imaging-plate readers. Further increase in the dynamic range may be possible;
4) a low non-uniformity (~ 1.3%) of the imaging plates simplifies flat-fielding;
5) a readout pixel size suitable for the purpose can be chosen;
6) readout of the imaging plates has no process in internal transfer of signal-like CCDs, and no traces due to after-images of bright stars appear. This is very important for the measurements of crowded fields;
7) when exposed to electrons, the imaging plate does not emit gas and vapour which damage a photocathode of the tube. No frequent replacement of the photocathode may be needed for the IPEC.

Unfortunately, I have no laboratory for a trial manufacture of an electrographic camera with which the imaging plates are tested. I wish to propose testing of the imaging plates to the groups which have available electronographic cameras. I hope that the superiorities mentioned above are not over-stated.

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