# Processing of data from an innovative parabolic strip telescope.

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## Abstract

This paper presents innovative telescope design based on usage of parabolic strip as objective. Isaac Newton was the first one to solve problem of chromatic aberration, which is caused by difference in refractive index in lens. This problem was solved by new kind of telescope with mirror used as objective. There are many different kinds of telescopes. The most basic one is lens telescope. This kind of telescope uses set of lenses. The next type is mirror telescope. Objective of such telescope can be concave mirror, spherical parabolic mirror or hyperbolically shaped mirror. Lens speed is depending directly on surface of the mirror. Both kinds can be combined. Such telescope composes of at least two mirrors and set of lenses. Light is bounced of the primary mirror to the secondary one and then to the lens system. This type has smaller sizes, but also smaller lens speed.

## *Introduction*

The greatest advantage of the parabolic strip telescope is its simpler and cheaper construction. Just two holders with cut-out for parabolic strip and strip from reflective flexible material are needed to create the objective. Tension in the strip material guarantees stability and precision of the reflective surface shape. Main idea of reconstruction is based on the same principle as CT (Computer Tomography); reconstruction of 2D image by usage of Radon transformation principle from 1D samples.

## Conclusion

We have proposed a fundamental modification of reflectors where the angular resolution can be better than in the case of usual objectives of the same area. The reconstruction of images exploits the discrete inverse Radon transform. The main advantages of such telescopes are

- good angular resolution,
- low expenses,
- simple technological development,
- possibility to install a grid of large telescopes across the Earth,
- lower weight for use on satellites.

The only major complication is that one more rotational movement is needed to reconstruct the image with the same angular resolution in all directions.

## References

[1] Chadzitaskos G. 2013, Parabolic strip telescope, arXiv: astro-ph/1304.6530

[2] ČERVENÝ, Jaroslav, Vladislav KOSEJK a Goce CHADZITASKOS. *Progress in Electromagnetics Research Symposium [proceedings]: The Principle of the Technology and Design of the Parabolic Strip Telescope*. China: Piers, 2014. ISBN 1559-9450.

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## Proof of principle

We have prepared a very basic experiment in order to proof that the principle works. Figure 2(left) shows parabolic strip telescope of lengths 30 cm. The artificial constellation was represented by series of LED diodes. The artificial constellations used in the experiment are shown in Figure 3 (left). The constellation has been rotated in steps of 5 degrees and the images had been photographed by an ordinary digital camera. Figure 2 (right) shows one of the photos. The reconstructed image is shown on Figure 1. Matlab was used for the image processing. The principle of the telescope has been successfully tested. The resulting image (Figure 3 (left)) can be compared with the reconstructed images. Usage of higher quality components and more measurements at finer angle steps, should result in the reconstructed image of much better quality. The good angular resolution can be used for direct observation of bright objects. The additive rotation is not necessary for some purpose. For example fast object recognition.

**Figure 1:** Final image after processing

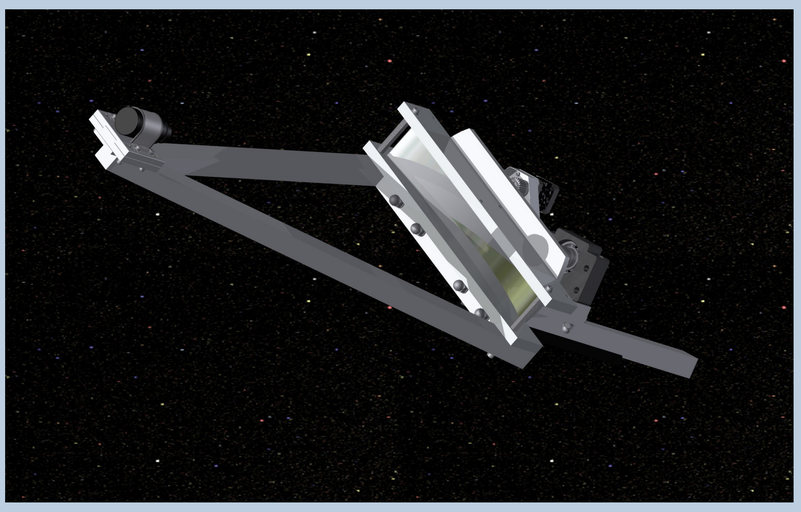
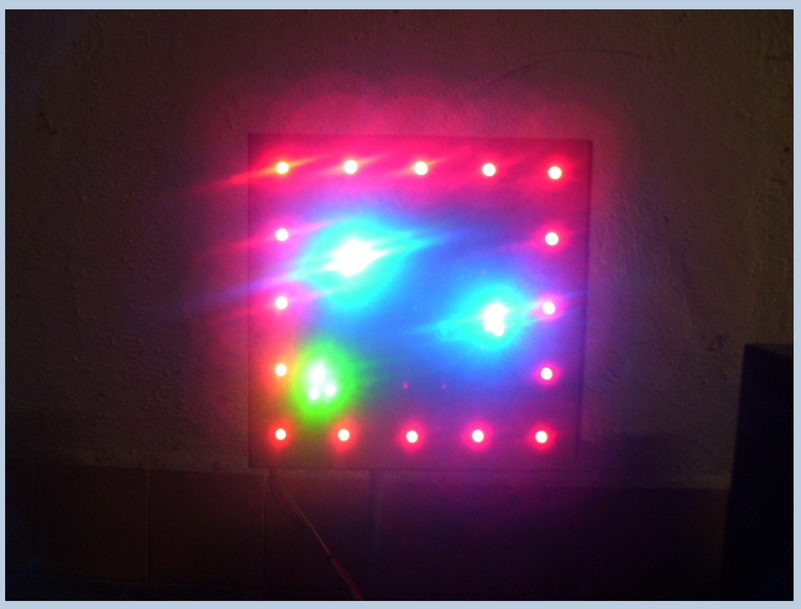


**Figure 2:** Parabolic strip telescop (left); Parabolic strip telescope on parallactic mount (right)



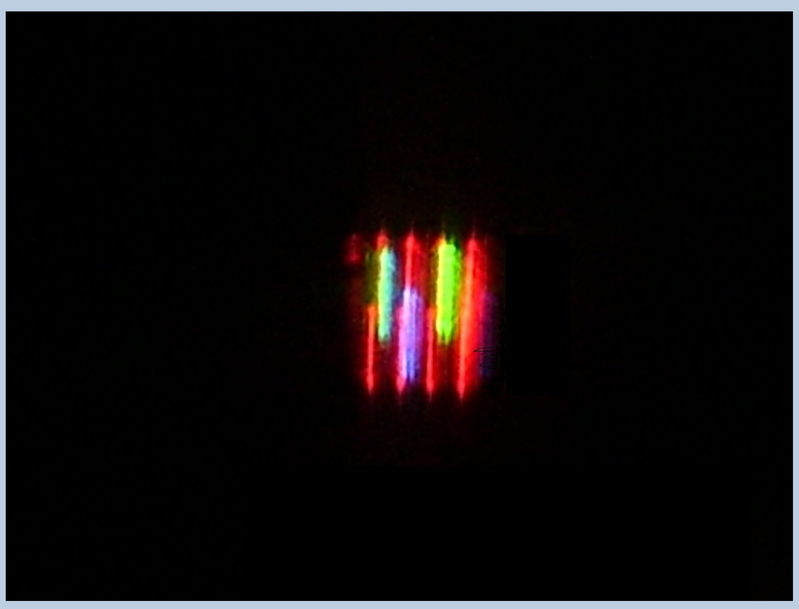


**Figure 3:** Artificial constellation (left); Image before pocessing (right)

## Data processing

The most basic algortithm for data processing is summation algorithm. It is based on sequential summation of projections (adjusted pictures taken during rotation of the telescope). The second is multiplicative algorithm is improved version of summation algorithm. It is based on mutual multiplication of picture matrixes. Main advantage of this algorithm is primarily in ability to easily clean dark point from final matrix and thus suppress noise in the reconstructed 2D picture. The third one is iterative algorithm. This approach is base on multiplication in steps. Pictures are divided into subsets. These subsets are multiplicated and until the reconstructed image is created. Idea of subsets came from CT image processing. Filtered Back Projection method is the last algorithm. This method was originally develop for reconstruction of the picture from CT. Final picture processed by this method is usually of very good quality and algorithm itself is very well adjustable for particular problem thanks to wide variety of filters.