



First science with SALT: Observations of an eclipsing polar

Accreting gas onto compact stars is a common occurrence in astronomy; it's one of the indirect ways in which we detect black holes, especially through their X-ray emission by the accreting gas. It's also believed to be the fundamental cause of the Type Ia supernova explosions by which we have recently measured the acceleration of the universe. The study to be described below is of a polar, an example of a compact object accreting gas from a nearby companion. Polars have the added feature that the compact object has a very strong magnetic field. They are the most readily accessible objects we know for studying gas accretion in strong magnetic fields.

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The Southern African Large Telescope (SALT) was inaugurated in November 2005. One of the capabilities which SALT and its instruments has, and which very few large telescopes have, is the ability to take very rapid pictures of stars. This is intended to enable us to study the rapid brightness changes in exotic stars. One such class of stars are called "polars". These are binary stars: two stars orbiting each other. Polars are amongst the closest binaries we know: the orbit of the two stars would fit inside the Sun! The polar which SALT has studied takes only one and a half hours to complete an orbit. Despite being a pair of stars, they are so close, you would see them as only one star in a telescope.

In the binary system which SALT has studied, one of the stars is like the Sun, only cooler, redder and about 1/3 of the mass and radius of the Sun.

The other star is a very dense white dwarf star: its mass is similar to the Sun's, but it is squeezed into the size of the Earth (whose diameter is about 1 per cent that of the Sun). The white dwarf's gravity is very large: white dwarf gas the size of a dice would weigh as much as a small truck.

The amazing thing about these binaries is that the white dwarf is gravitationally sucking the outer layers off its companion. The white dwarf also has a huge magnetic field (30 million times the Earth's magnetic field) which channels the gas coming off the cool star down to its magnetic poles. *Figure 1* is an artist's impression of what a typical such binary system might look like: the cool, red star is in the background with the stream of gas being sucked off it (shown in white) and finding its way down to the white dwarf shown at lower right.

Imagine now looking at a binary system like this from "behind" the cool, red star with your viewing angle such that the red star, once in orbit, eclipses the white dwarf and cuts off your view of it. If you had a telescope like SALT, and a camera on it like its camera SALTICAM, which can make brightness measurements every 100 milliseconds, you would see the brightness of the system dim because the light from the gas crashing on to the magnetic poles of the white dwarf completely outshines the light from everything else. *Figure 2* illustrates of your view of the system at the start of eclipse (left) when the red star is just about to eclipse the one magnetic pole, labeled Spot 2, and at the end of the eclipse (right) when the red star has just uncovered Spot 2.

Figure 3 is a sequence of brightness measurements and the evidence for what has just been described can



Figure 1. The artist Bob Watson's painting of a "Polar".

Address at the Inaugural ceremony

Welcome after 39 Years

Lubos Perek

Ladies and Gentlemen,
At the thirteenth General Assembly of the IAU, held 39 years ago, I had the privilege to invite the audience to meet again soon in Prague. Thirty nine years is a short time in astronomy but in human life it means two generations. Many things have changed in that time. All branches of astronomy made substantial advances thanks to space research, to computer technology, and, in first place thanks to a larger number of human brains working in the field. It is impossible to give an account of all new discoveries and of new understanding of old problems. Be referred to 200 volumes of IAU Symposia and 200 volumes of IAU Colloquia which appeared in those 39 years.

There are things, however, which have not changed. Among them is the individual membership in the IAU, an important support of personal contacts across space and time. As regards space, we greet astronomers from 75 countries. As regards time, connecting past with the present, we have in Prague four former presidents of the IAU. The youngest, in terms of service, is Franco Pacini, whose name is closely connected with rotating neutron stars. He was preceded by Lodewijk Woltjer, a supporter of the Very Large Telescope at Mount Paranal. Yoshihide Kozai stands for lunisolar perturbations of satellite orbits. The oldest in service is Adriaan Blaauw. He put all runaway stars into their place in an improved cosmic distance scale. More than half a century ago, I had the honor and pleasure to share an office with Adriaan at the Leiden Observatory, where the atmosphere consisted not of air or oxygen but of pure astronomy.

Seven former General Secretaries, who devoted part of their lives to the IAU, are among us, starting with my predecessor, Jean-Claude Pecker, my lifelong friend, who attended more IAU congresses than anybody else. My successor, Kees de Jager, made the Sun his permanent residence. Further Jean-Paul Swings, supporter of Mars exploration. Derek Mc Nally, fighter against adverse environmental impacts, Johannes Andersen, director of the Nordic Optical Telescope, and Hans Rickman, observer of the comet impact on Jupiter. Names of all former presidents of commissions, professors, and colleagues who connect the past with the present are too many to be listed here and now. They are all welcome, as well as all those who will become friends and colleagues at this Assembly.

Ladies and Gentlemen, next time, please, do not wait 39 years. You are welcome any time.



be seen there sequence. If you look closely at *Figure 3*, you will see it has a first sudden brightness drop (Spot 2 disappearing), followed about 25 s later by a second sudden brightness drop (Spot 1 disappearing). Towards the end of the sequence there are sudden rises in brightness corresponding to the earlier sudden drops as the spots are uncovered. The gas stream between the stars also gives some light, and this accounts for the rounded shape of the bottom of the eclipse.

This sequence of measurements is better than anything that has been obtained before, and has been described in full scientific detail in the first scientific paper (or report) on the science from SALT.

These results have been accepted for publication in the scientific peer-reviewed journal *Monthly Notices of the Royal Astronomical Society*. An electronic preprint of the article is available online at <http://xxx.lanl.gov/archive/astro-ph>, entry number 0607266.

SALT is especially suited to studying objects of the kind just described. Amongst the world's currently largest telescopes, it has a significant advantage over all the others for this kind of

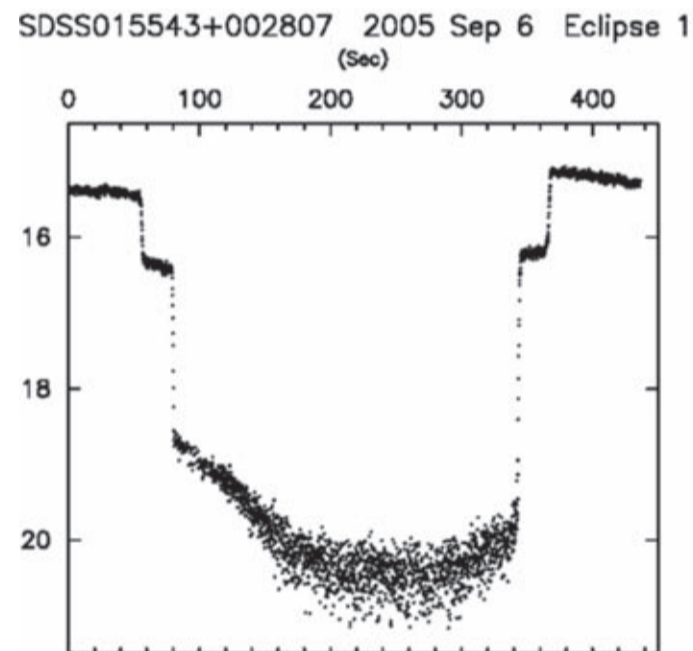


Figure 3. Sequence of brightness measurements of the polar. Each point is a 112 millisecond exposure.

research, which will undoubtedly enable its astronomers to probe the mysteries of this kind of star.

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Figure 2. Earth observer's view of a polar at the start (left) and end (right) of eclipse.

