RECORDING THE CALCIUM SPECTRUM IN CAPILLARY LAMP

Yu.N. Bondarenko[1], P.V. Scheglov[2]
[1] Astronomical Observatory, Odessa State University
[2] Sternberg State Astronomical Institute, Moscow

ABSTRACT. Considered possibility of fabrication in laboratory conditions of special tubes with metals vapours of increased brightness. Shown possibility of their use for astronomical instruments.

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Calcium is an element of the II Group of the Periodic System. It is an alkaline-earth metal possessing the considerable vapor pressure only at hundreds degrees above zero and very high affinity for oxygen. The same properties are shown by other alkaline-earth metals, such as magnesium and lithium. So, everything mentioned below as characteristic for calcium is also actual for these elements.

All of them interact with glass and quartz showing the flash, and their vapors also destroy these materials making them opaque. Thus, it is really difficult to make the spectral lamps with these elements. However, it is possible to avoid the undesirable chemical reactions in the lamps, for example by introducing the metals as iodides (Yushkov, 1984) or by spraying them within the hollow cathode (Moskalenko, 1969). The former method was tested using the "beads" with the high frequency excitation and it did not show any good results. Quartz was readily crystallized and the lamp flask was destroyed, as even the micro traces of CaO catalyze quartz crystallization. The discharge with the filled cathode is not always acceptable, since too many lines in it are excited (Moskalenko, 1969) which is generally undesirable.

Taking into consideration the inertness of Ca for the transition metals, it seems advisable to use the accessories made of these metals (Brauer, 1985) for the evaporation of Ca.

The lamp we have developed can be considered "capillary", as in spite of the presence of the hollow cathode it is used only as the source of electrons and as the "stove" for evaporation of Ca. The evaporated atoms due to diffusion enter the discharge where they are excited and emit the "arc" lines.

The design of the device is as follows: The cylindrical flask of molybdenum glass contains the hollow cathode of iron or molybdenum which is located on the long holder. Within it, behind the perforated diaphragm, the alloy Ca-Al with the content of Ca 50%, stable on air, is placed. The cavity of the cathode, in the simplest case, is closed by the iron diaphragm with the hole 0.7-1.5 mm in diameter. In general, both cathode and diaphragm should be made of molybdenum, due to its high conductivity, however, it is hardly accessible and poorly processed. Near the hole on the diaphragm the anode of the titanium plate of rather large surface (1-2 cm) is located. It also serves as a getter, and at the work of the lamp it must not be heated too much in order to avoid the back hydrogen release. At the end face of the cylinder the plane glass window or collecting lens is welded in which brings into focus the image of the discharge capillary tube on the end face of the light guide. Due to the fact that the discharge shows sometimes the trend to burn on the external surface of the cathode, the latter is sealed from the outside by the sleeve made of Polycor or Alundum. Quartz does not suit for this purpose, as it is destroyed by the Ca vapors and splitted at the cathode heating. The lamp is filled with He or Ar at the pressure 50 mm Hg. The pressure of the gas is not very critical, however, it influence the lifetime, as it sharply decreases the diffusion of Ca vapors from the cathode. At too high pressure the discharge transforms into the arc form with the cathode spot more readily which will cause the unstable work of the lamp. The helium inflation results in less quantity of the extra lines, since the light He atoms spray the cathode and discharge cathode walls, however He possess extremely high thermal conductivity, so higher current is needed for heating cathode in it. It should be noted that the similar (though not soldered off) source was manufactured by Paschen (Moskalenko, 1969), however, in this source gas filling was not used. In addition, this source acted as HCL (Moskalenko, 1969). The buffer gas in our lamp accomplishes several functions: it provides the initiation of the cold lamp, prevents both the drift of the metal on the walls and its spraying onto the outlet window. As both He and Ar posses much higher ionization potential than Ca, the atoms of the latter, being ionized within the discharge are transported back into the cathode. This phenomenon is called cataphoresis. And since it is in proportion to the square of the number of the current density, it is obvious that in order to increase the lifetime the capillar diameter should be minimal. In this case the surface brightness of the discharge would also increase. Using cataphoresis for the absolute suppression of the metal vapor diffusion from the cathode, thus creating the "perpetual lamp", demands the accurate calculation of the mode of operation, in particular, strict observance of the heat condition of the cathode, as the pressure of the vapors significantly (exponential curve!) depends on temperature. This phenomenon has not been investigated in our work for the different reasons. At the combustion of the discharge in the iron capillary tube the spectrum is contaminated by its lines. In order to increase its purity we have made two samples of lamps with the porcelain capillary tube which prevented the undesirable lines of iron.

The operating current of the lamp which influences the cathode temperature, thus influencing the pressure of the metal vapors was chosen so that the irradiation of the inert gas was suppressed almost completely. Here, the metal lines are narrow and bright enough.

We have manufactured the lamps of this type with Ca, Mg, Li, and Tl. Then we have investigated the spectral lines of Ca and Tl. The coherence value for Tl was 80 mm (l/Dl = 16000). At the lamp lighting the evaporated metal was sprayed on the flask walls near the cathode, the outlet window being clean.

Tha similar construction of the lamps can be used for the work with the active metals with the temperature of the visible evaporation less than 1000 C in the case when the increased brightness of the source is needed. The lamp with Tl was used at the work with the double frequency Fabry-Perot interferometer for observing the planetarium nebulae.

References:

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