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**Alfvén H & Carlqvist P.** Currents in the solar atmosphere and a theory of solar flares. *Sol. Phys.* 1:220-8, 1967.
[Royal Institute of Technology, Stockholm, Sweden]

This paper presents a theory of solar flares based on electromagnetic phenomena. The flare energy is supposed to be stored as magnetic energy in one or several current filaments penetrating the solar atmosphere. By analogy with results obtained in experiments with mercury rectifiers, the stored magnetic energy is rapidly released as a flare when the electric current exceeds a certain critical limit. [The *SCI*® indicates that this paper has been cited in over 155 publications.]

## Solar Flares and Current Interruption

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It was the fall of 1966 and *Solar Physics*, a journal for solar research, was about to be started. Our intention was to contribute with an article on a model of solar flares in one of the first issues of the new journal. The article, which constitutes a development of an earlier paper,[1] was worked out with considerable intensity and rapidity at the Royal Institute of Technology, Stockholm, Sweden, and was completed within the course of a few weeks.

Already in the 1950s, it was realized that the phenomenon of solar flares might have an electromagnetic origin and that the flare energy is likely to be stored as magnetic energy in the solar atmosphere. It was not an easy task, however, to explain how the stored magnetic energy could be released, within the short time observed, from the hot solar atmosphere that was usually considered to have an almost infinite conductivity. Hence, the mechanism for energy release in flares naturally became a main subject of our study.

The idea behind the flare model considered had its source in certain technical problems related to the electrical power supply system in Sweden. In experiments it had been found that, if the electric current in a mercury rectifier was increased above a certain critical limit, the current through the rectifier became interrupted within a small fraction of a second. As a result of the interruption, the electric energy of the whole circuit was concentrated to and released in the rectifier with disastrous consequences. The current interruption was caused by an electrostatic double layer of high impedance that through some instability locally replaced the normally well-conducting mercury plasma in the rectifier. In our paper we suggested that a similar kind of double layer might arise in current systems penetrating the solar atmosphere and there lead to explosive release of magnetic energy in the form of flares. It is remarkable that the phenomenon that caused so much trouble in the rectifiers turned out to be a potential mechanism for energy release in solar flares. The flare mechanism described in our paper is in reality nothing but a straightforward combination of a phenomenon that is well known from laboratory experiments in plasmas and rectifier studies on the one hand and solar physics on the other. The reason our flare theory was not proposed much earlier is that groups working on double layers and groups working in astrophysics did not have good contact with each other.

As a result of the flare model, a theory of relativistic double layers has been developed.[2] In such double layers, both electrons and ions are accelerated to velocities close to the velocity of light. It should also be emphasized that the understanding of ordinary double layers has improved very much during the last two decades.[3] The general interest in the field is perhaps best reflected by the fact that up to now three conferences have been devoted to the physics of double layers.[4-6]

If we go through astrophysics—or any other field of science—we will find that progress is delayed—often by many decades—by lack of contact between groups working in different fields. The progress of science consists in reality of two equally important processes. The first is the generation of new ideas. The second is the destruction of generally accepted ideas that prevent the further advance of science.

1. **Jacobsen C & Carlqvist P.** Solar flares caused by circuit interruptions. *Icarus* 3:270-2, 1964. (Cited 10 times.)
2. **Carlqvist P.** On the acceleration of energetic cosmic particles by electrostatic double layers. *IEEE Trans. Plasma Sci.* PS14:794-9, 1986. (Cited 5 times.)
3. **Raadu M A.** The physics of double layers and their role in astrophysics. (Whole issue.) *Phys. Rep.—Rev. Sect. Phys. Lett.* 178(2), 1989. 97 p.
4. **Michelsen P & Rasmussen J J,** eds. *Symposium on Plasma Double Layers.* 16-18 June 1982, Risø, Denmark. Roskilde, Denmark: Risø National Lab. 1982.
5. **Schrittwieser R & Eder G,** eds. *Proceedings of the Second Symposium on Plasma Double Layers and Related Topics.* 5-6 July 1984, Innsbruck, Austria. Innsbruck: University of Innsbruck, 1984. 411 p.
6. **Sandulovicíu M & Popa G,** eds. *Third Symposium on Plasma Double Layers.* Bucharest, Romania. 1987.




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