

## RESEARCH REPORT

# Unexplained Temporal Coincidence of Crystallization

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**Abstract**—In a simple class cooling curve experiment in 1950, 15 spatially separated containers of supercooled sodium sulfate solution were observed to spontaneously crystallize in three sets of unexplained temporal coincidences. The students had been instructed to induce crystallizations 10 minutes before they had to depart, if spontaneous crystallizations had not occurred by this time. No student actually induced a crystallization. Fortuitously, the students had prior commitments to depart at three different times. There was a one-to-one correspondence between the pre-arranged student departure times and the times of the spontaneous crystallizations.

*Keywords:* nonlocal crystallizations — coincidences — supercooled sodium sulfate solution — future interconnections — metastability

## Introduction

In early April 1950, the senior author asked a group of 15 students to measure individually the cooling curve of concentrated sodium sulfate solution. The junior author was one of the 15 students. At the start of an 80-minute laboratory class, each student poured 200 ml of hot concentrated sodium sulfate solution prepared in advance into a 400 ml beaker. The students were told to take temperature readings with a mercury-in-glass thermometer once every minute, to partially cover their beakers with a piece of paper until the solution temperature had cooled to 30°C, and to induce crystallizations 10 minutes before they had to depart if a spontaneous crystallization had not occurred by this time. The room temperature was 27°C until a malfunctioning heating system was switched off completely at the 45-minute mark, with several top windows being opened shortly afterward to admit outdoor air at about 8°C. All students removed their covers more or less together at the 60-minute mark when the room temperature had cooled to 21°C.

### The Three Sets of Temporal Coincidences

By happenstance, the junior author's attention wandered back and forth between observing his own beaker and registering what was happening to the beakers of the other students. The first crystallizations occurred spontaneously in temporal coincidence in eight beakers randomly distributed around the classroom just before the 70-minute mark. These events were reported virtually in unison by the students concerned with remarks such as "mine's gone." At the time of the crystallizations, there was some background chatter going on in the room, but no sudden change in the noise level. The air temperature had dropped to about 19.5°C. There was no obvious cause to which the crystallizations could be attributed. However, as the first eight students departed about 10 minutes later, each left the door open behind him, and this slammed shut with an enormous bang soon afterward in the noticeable cross-draft from the windows to the door. None of the five or six door-slamming and cross-drafts triggered any further crystallizations. The background chatter died out completely with their departure.

That the first set of spontaneous crystallizations had occurred in temporal coincidence registered in the junior author's brain as being remarkable, especially when the door-slamming and cross-drafts induced no further crystallizations. Idly wondering whether the phenomenon would be repeated, he deliberately controlled his attention so that it oscillated back and forth between observing his own beaker and watching what was happening with the beakers of the other students. The next crystallizations occurred spontaneously in fairly precise temporal coincidence in four randomly distributed beakers just before the 90-minute mark in a completely silent room. By then, the air temperature must have been about 18°C. Again, there was no obvious cause to which the crystallizations could be attributed. As before, cross-drafts and door-slamming followed about 10 minutes later in the wake of each of the departing students without inducing any further crystallizations.

The junior author was astonished by the second set of crystallizations occurring in temporal coincidence. After the departure of the second group of students, he suddenly realized that nobody else had actually noticed either temporal coincidence phenomenon, because he had been the only one watching the collective behaviour of all the beakers. Up to this time, the senior author's main attention had been devoted to marking at a separate laboratory bench at the front of the room. The junior author therefore broke the silence in the room to tell the senior author, in the hearing of the other two remaining students, that all the crystallizations so far had been spontaneous and had occurred in two sets of temporal coincidence without obvious cause. He inquired if there was any explanation for this; and, in particular, if the three remaining beakers were likely to undergo spontaneous crystallizations in temporal coincidence. The senior author responded that temporal coincidences of this sort were quite impossible, and that—although he himself had not been watching—the junior author must be mistaken in saying that two had occurred. He

suggested that most of the departing students must have induced crystallizations 10 minutes before they had to leave, as they had been instructed to do. Nevertheless, the senior author abandoned his marking and positioned himself so that he could clearly observe two of the remaining beakers and also watch what was happening at the third beaker some distance away. All four persons were hungry. At the 110-minute mark, they agreed that, as they did not want to be late for the start of the second sitting of school lunch, crystallizations would have to be induced at the 120-minute mark if they had not occurred spontaneously before this time. It was decided that the crystallizations would be induced with crystals from the mother fluid to which the other students had returned their crystallized solutions. All discussion then ceased.

The last three crystallizations occurred spontaneously in exact temporal coincidence, with a precision of less than a second, just before the 120-minute mark in a room that was completely silent. Each student exclaimed that his spontaneous crystallization had occurred at almost the last possible moment, because he was just about to induce a crystallization. All three crystallizations were almost explosive in nature. The junior author thought that the spontaneous crystallization had started from a single origin in the interior of the fluid, whereas the other two students thought that the spontaneous crystallizations in their beakers had started from a single origin on the open surface. The air temperature must have been about 16°C. For the third time, there was no obvious cause to which the spontaneous crystallizations could be attributed. All present, including the senior author, were absolutely sure that there was an exact temporal coincidence with no obvious explanation. The senior author still maintained that the junior author must have been mistaken in his claim that there had been two earlier temporal coincidences of the same kind. He therefore asked the junior author to check with all the other students to see how many of them had induced crystallizations in their beakers.

### **The Postmortem Investigation**

Within the next 24 hours, the junior author questioned each of the other 12 students separately about what had happened during the course of the experiment. He wrote down notes on everything that was said, whether or not it seemed relevant. In response to a direct question as to whether the crystallization in his beaker had been spontaneous or induced, each student insisted that there had been a spontaneous crystallization and categorically denied inducing a crystallization. Each student then went on to volunteer the information that he was just about to induce a crystallization in his beaker, and was actively thinking about how to do it, when the spontaneous crystallization actually occurred. Furthermore, each of the 12 students then felt obliged to justify in some detail his having to leave when he did, as this was why he had been about to induce a crystallization. The first group of eight students all had good reasons for departing at the normal end of morning school. The second group of four students had valid reasons for departing at the latest possible time that

permitted them to attend the first sitting of school lunch. The junior author noted all this information down and then inquired what details of the onset of crystallization could be recalled. All 12 students, except one who had briefly been out of his place, said that they thought that the spontaneous crystallizations in their beakers had had a single origin on the open surface.

Upon going through all the written notes, the junior author noted something most remarkable. There was a one-to-one correspondence between the time each student had said he had a prior commitment to leave and the time the spontaneous crystallization had actually occurred in the same student's beaker. The junior author confirmed the validity of this one-to-one correspondence by going back to each student to double check. After much reflection, the junior author unilaterally decided that this one-to-one correspondence could not possibly have any relevance whatsoever to the observed temporal coincidences, because any alternative conclusion seemed just too preposterous to contemplate.

The junior author then reported back to the senior author that none of the other students had induced crystallizations in their beakers. Regrettably, he did not mention anything about the remarkable one-to-one correspondence between the predetermined departure times and the actual spontaneous crystallization times.

### **The Senior Author's Conclusions in 1950**

In the reported experiments, the junior author observed three unexplained temporal coincidences consisting of eight, four, and three spontaneous decahydrate crystallizations in beakers of supercooled concentrated sodium sulfate solution. The senior author confirmed the validity of the last temporal coincidence involving three spontaneous crystallizations, but was inclined to think that the observations of the temporal coincidences involving eight and four spontaneous crystallizations must have been mistaken in some way.

If just the third temporal coincidence actually occurred, then the logically possible explanations are either:

- (a) the cause was something known—such as a sound wave, air current, or building tremor—which was not detected by the sense organs of those present;
- (b) there was a chance juxtaposition of random events in time that is unlikely to be repeated;
- (c) the cause was something unknown.

If all three temporal coincidences actually occurred, despite the serious doubts of the senior author, then (b) can be virtually ruled out. In either case, (c) is extremely unlikely.

### **The Junior Author's Postscript in 2001**

The senior author's conclusions in 1950 were scientifically correct then and remain so today. However, they were incomplete because they were stated without any knowledge of the one-to-one correspondence between the predetermined departure times and the actual spontaneous crystallization times. The senior author's instructions that the students should, if necessary, induce crystallizations in their beakers 10 minutes before they had to depart had the following inadvertent consequence. In the present time at the start of the experiment, three separate multiple spatial interconnections were imposed on the futures of containers of supercooled concentrated sodium sulfate solution that were to be spatially separated during most of the experiment. It follows that there is a logical possibility that these certain significant future interconnections caused the temporal coincidences in some unknown way.