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PERSISTENT SPECTRAL HOLE BURNING SPECTROSCOPY OF HIGH PRESSURE EFFECTS IN A WINDOWLESS PRESSURE UNIT

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KÕRGRÕHUSPEKTROSKOOPIA OPTILISTE AKENDETA RUUMIS SPEKTRITE PÜSISÄLKAMISE KAUDU. Karl K. REBANE

ЭФФЕКТЫ ВЫСОКИХ ДАВЛЕНИЙ, ИССЛЕДОВАННЫЕ ПУТЕМ ФОТОВЫЖИГАНИЯ УСТОЙЧИВЫХ СПЕКТРАЛЬНЫХ ПРОВАЛОВ В КАМЕРАХ БЕЗ ОПТИЧЕСКИХ ОКОН. Карл К. РЕБАНЕ

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The conventional consideration of optical studies of matter under high pressure supposes that the sample chamber must have at least one optical window to let the light in and out. Actually it is not needed: optical measurements are also possible in the absence of windows.

The point is the exploitation of the possibility of *memorizing* the deformation field in solids by means of persistent spectral hole burning [1, 2]. Holes may be burnt in when the sample is under pressure. More precisely, a profile resembling the emission spectrum of the source will be burnt in and memorized [3]. The positions and shapes of the holes (the profile) are to be measured after pressure is released. Comparison of the hole profile for different positions in the released sample with the profile burnt in the spectrum of the unloaded sample can give the picture of the effects of pressure.

How to burn spectral holes in a sample caged in the middle of a high-pressure unit absolutely non-transparent for external light? Obviously, the light source must also be caged in the unit. It seems really difficult, if not impossible, to put into the cage some single-mode laser device or other very narrow, i. e. $\Delta\omega < 0.1$ cm^{-1}, line source. Some kind of radioluminescence source or an amount of substance in which a

large quantity of photoluminescence (phosphorescence) excitation is stored should not be difficult to instal. The first choice is preferable because of the big capacity to keep the level of luminescence high for a very long time, but protective measures against spectral diffusion caused in the sample, e. g. screening the sample off from the radioactive irradiation, must be taken.

We suppose that the unit is cooled down to low temperatures, e. g. liquid helium temperatures $T \approx 2$ K. (The cooling could also be used to create pressure in the sample.) If the source emits luminescence whose spectrum comprises at least one sharp and intense purely-electronic or vibronic zero-phonon line (ZPL), the spectral resolution can be quite fine. In the first case the excitation line width may be as small as 0.1 cm^{-1}, in the second, 1 cm^{-1}; the corresponding hole width is twice as large. These hole widths are, of course, 1—3 orders of magnitude larger than those determined by the homogeneous purely-electronic ZPL width and achievable by means of single-mode lasers, but still small enough to serve as sensitive indicators of the pressure-induced shifts and changes of hole shapes. To burn in profiles deep enough, sample and source may be kept together under pressure for a very long time if necessary. Slow hole burning is even preferable, because the influence of transient pressure values would be suppressed.

The advantage of the method is that optical measurements at very high pressures (up to 10^5 atm) should become possible. The disadvantage is that the properties of the light source are also changed by pressure and actually the sample and the light source are simultaneously under study.

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