procedure has been adopted for evaluating the
J numbering and the rotational constants. The
rotational and the molecular constants thus
obtained are collected in Tables I and II.

<table>
<thead>
<tr>
<th>Table I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rotational constants of A-X bands of $^{208}\text{Pb}^{235}\text{Cl}$</strong></td>
</tr>
<tr>
<td>$v', v''$</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>6, 0</td>
</tr>
<tr>
<td>4, 0</td>
</tr>
<tr>
<td>Constants obtained by earlier workers$^1$</td>
</tr>
<tr>
<td>6, 0</td>
</tr>
<tr>
<td>4, 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table II</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Molecular constants in the X $^2\Pi_1$ and A $^2\Sigma^+$ states of $^{208}\text{Pb}^{235}\text{Cl}$</strong></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>X $^2\Pi_1$ State</td>
</tr>
<tr>
<td>$B_0=0-11682$ cm$^{-1}$</td>
</tr>
<tr>
<td>$r_0=2-170$ A</td>
</tr>
<tr>
<td>$I_0=235-904 \times 10^{-40}$ gm. cm$^2$</td>
</tr>
<tr>
<td>$\alpha=0-00032$ cm$^{-1}$</td>
</tr>
</tbody>
</table>

In the (6, 0) band (Fig. 1) we can see
groups of three closely-spaced lines continuing
from lower to higher J values. The relative
separation among the lines in a group is con-
stant throughout and is equal to the vibra-
tional isotopic separation (because the rota-
tional isotopic separation is negligible). It
may be mentioned that in the spectrum
recorded earlier,$^1$ the three lines in each group
were not resolved and a broad diffuse line was
observed; one edge of which was taken to
be forming the P branch and the other to be
forming the R branch.

For most of the mono-fluorides of IV. group,
it has been experimentally verified that the
A-X$_1$ band system is due to the transition
$2\Sigma^+ - 3\Pi_j, 2^+$ $^5$. The structure in this case also
suggests that a case (c) equivalent of $2\Sigma^+ -
3\Pi$ represents the band system.

The authors are grateful to Prof. N. L. Singh
for his interest in the work.

Dept. of Spectroscopy,
O. N. SINGH
Banaras Hindu University,
I. S. SINGH.
Banaras, December 9, 1967.


**INFLUENCE OF CRYSTAL DEFECTS ON PHOTOANNEALING OF CHEMICAL RADIATION DAMAGE**

MOHANTY AND NAIR$^1$ have recently shown that
chemical radiation damage in lead nitrate
recovers on exposure to light in the visible
region. It is well known that crystal defects
render a substance more susceptible to thermal
annealing.$^2$ The present work shows that
defects influence also the photoannealing of
chemical radiation damage.

Two samples of 85 to 100 mesh size lead
nitrate crystals from the same batch were
irradiated, one with 50 Mrad of $^{60}$Co $\gamma$-rays
at the dose rate of about 1-5 Mrad hr.$^{-1}$ and
the other close to the core (temperature
$<45^\circ$ C.) of the Bhabha Atomic Research
Centre water moderated reactor. ApSara so as
to receive the above dose of $\gamma$-rays at the dose
rate of about 10 Mrad hr.$^{-1}$ and, in addition,
$5 \times 10^{13}$ nvt fast and $2-2 \times 10^{16}$ nvt slow
neutrons. The two irradiated samples thus
differed in that whereas in the sample irradiat-
ed with $\gamma$-rays alone the damage was almost
entirely chemical, in the sample irradiated
with $\gamma$-rays plus neutrons, in addition to the
chemical damage, a considerable concentration
of displacements were present having been
generated by the knock-on collisions of
chiefly the fast neutrons.

The procedures employed for studying the
kinetics and the wavelength dependence of
photoannealing were the same as described
previously.$^1$

Typical plots of the damage nitrate con-
centration versus the time of illumination are
given in Fig. 1. The plots are linear as for
a first order process. The material irradiated
with $\gamma$-rays plus neutrons undergoes, photo-
annealing at a greater rate than that irradiated
with $\gamma$-rays alone: the velocity constants are
respectively 0-00432 and 0-000173 hr.$^{-1}$ It is
seen from Fig. 2 that for a given light frequency
the recovery is also greater for reactor irradia-
tion than for pure $\gamma$-rays. The recovery in
both cases is linearly related to the light
frequency. It is, however, significant that the
threshold frequency for annealing, viz., $42 \times
10^{13}$ sec.$^{-1}$ corresponding to 1-74 ev and
40-1 keal mole$^{-1}$, is independent of the defect
concentration.

The authors thank the Bhabha Atomic
Research Centre, Bombay, for assistance with
the irradiations.
FURTHER INVESTIGATIONS ON THE $\gamma$-PHASE OF $p$-DICHLOROBENZENE

Following the work reported in two earlier communications\textsuperscript{1,2} on the NQR observations on the $\gamma$-phase of paradichlorobenzene, a more detailed study of the Zeeman effect has been made on a number of single crystals of this compound, at different temperatures, with a view to study the changes, if any, in (a) the bond character and (b) the relative orientation of the C-Cl bond during the transition into the $\gamma$-phase. A series of measurements have also been made on the frequencies at different temperatures in both the powder and single crystals. Analysis of all the observations has revealed the following new results.

1. The orientation of the field gradient axis, with respect to the laboratory co-ordinate system, for the crystal, grown from melt, in the $\beta$-phase, at the laboratory temperature is measured as $(\theta_2, \phi_2) = (74^\circ 2^\prime, 114^\circ)$. This value is in agreement with that for $\beta$-phase, reported by Dean.\textsuperscript{3}

2. Zeeman measurements at about $-15^\circ$ C. on the single crystals in the $\gamma$-phase have shown that the orientation of $Z$-axis of the field gradient in the Laboratory co-ordinate system is $(\theta_2, \phi_2) = (117^\circ 7^\prime, 89^\circ)$.

3. The relative orientation of the field gradient axes of the $\beta$- and $\gamma$-phases is calculated to be $49^\circ 8^\prime$.

4. Following the method adopted by Meal, the bond character of the C-Cl bond has been estimated for the $\gamma$-phase and compared with the corresponding values of the $\alpha$- and $\beta$-phases reported in literature.

<table>
<thead>
<tr>
<th>Molecule</th>
<th>$C^-\text{Cl}^+$ %</th>
<th>$C^+\text{Cl}^-$ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p$-dichlorobenzene $\gamma$-phase (author)</td>
<td>2.37</td>
<td>20.25</td>
</tr>
<tr>
<td>$p$-dichlorobenzene $\alpha$-phase (Dean)</td>
<td>2.26 ± 0.7</td>
<td>20.4 ± 0.7</td>
</tr>
<tr>
<td>$p$-dichlorobenzene $\alpha$- and $\beta$-phases\textsuperscript{4}</td>
<td>1.68 ± 0.7</td>
<td>20.9 ± 0.7</td>
</tr>
</tbody>
</table>

It is observed that the changes in the orientation of the field gradient axes do not seem to have given rise to any large changes in the bond character, during the phase transition.

The author is indebted to Prof. K. R. Rao for his valuable guidance. She is thankful to the C.S.I.R., New Delhi, for the award of a Research Fellowship.

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