sible. It remains to be determined, however, to what extent they can be put to practical use.

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SENSITIVE TUNABLE ACOUSTICAL PHONON DETECTOR

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For a wide range of problems it would be of great interest to have a sensitive tunable narrow-band phonon detector, which could measure the spectral distribution of acoustical phonons in the gigahertz frequency range. We would like to propose that such a spectrometer can be constructed using impurity ions which show paramagnetic magneto-optic effects when put into optically clear solids. In its simplest form the ground state of the paramagnetic ion should be a Kramers doublet whose spin-lattice relaxation rate is determined by the direct one-phonon process. The spin temperature is then directly related to the effective temperature of the phonons within the paramagnetic resonance linewidth centered at the Larmor frequency $h\nu = g\beta H$. The spin temperature can be monitored optically by using an appropriate magneto-optical effect (circular dichroism or Faraday rotation), which can be done with high sensitivity.[1-7] Optical detection of the spin temperature has the advantage that it can be done freely at any Zeeman splitting, which cannot be done conveniently using normal microwave techniques; further, by focusing the monitoring light beam any small region of the crystal can be examined. Thus, by sweeping the magnetic field while optically detecting the spin temperature, any anomalies in the phonon spectral distribution in the crystal can be easily detected, and by moving the light beam the spatial distributions of these anomalies can be found.

The bandwidth of such a detector would be the linewidth of the epr absorption line. The upper frequency limit to the tuning would be limited by the strength of the obtainable magnetic field. The lower frequency limit to the tuning would be determined by the point where the spins are no longer primarily "on speak-

ing terms" with the resonant phonons, for which there is no simple criterion. It is desirable to keep the interaction between the paramagnetic centers and the phonons weak so that the phonon distribution is not distorted; because of this such a detector would normally have a relatively slow response time. The most promising systems we know of for constructing such a phonon detector are the F center in the alkali halides[3] and divalent thulium in the alkaline-earth halides,[7] sinch both have strong paramagnetic circular dichroism and under certain conditions the spins are coupled primarily to the resonant phonons.

Most of the references are concerned with the application of classical optical pumping techniques, such as those used to study the alkali vapors, to paramagnetic centers in solids. In the solid the spins interact with the lattice vibrations instead of with a buffer gas or container walls, but the optical techniques can be used to study the spin-phonon interactions as they can be used to study the corresponding interactions in the vapor. The important new point is that once the spin-phonon interaction is understood in a particular crystal, these techniques can be used to study the phonons in that crystal.

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DAVYDOV SPLITTING OF THE ^2E LINES IN ANTIFERROMAGNETIC Cr_2O_3

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This Letter reports the observation of a Davydov splitting in the optical absorption spectrum of Cr_2O_3. In zero external field, a transition to only one level of the Davydov pair is observed. With H parallel to the c axis, an additional line having a field-dependent absorption appears. The extrapolated zero-field splitting is 3.75(±0.25) cm^{-1}.

The recent observation of two-magnon absorption[1] and magnon side bands[2] in some transition-metal fluorides has stimulated an investigation of the spectra of other transparent antiferromagnets. This paper is the first report of the observation of a Davydov splitting[3] in the optical exciton spectrum of an antiferromagnet, Cr_2O_3.[4]

Wickersheim[5] has investigated the sharp line-absorption spectrum of Cr_2O_3, and Stager[6] has measured the Zeeman effect of these lines. There are four sharp lines with the following energy (cm^{-1}) and polarization: 13 747.0, σ, 13 769.5, π, 13 909.5, π, and 13 931.4, σ. The positions of the absorption lines were found to be slightly crystal dependent. The energies given here are approximately 5 cm^{-1} higher than Wickersheim's data. Their explanation was in terms of the single-ion molecular field approximation and was found to be inadequate to explain the observed results. A more appropriate description of the excited states of insulating concentrated crystals is in terms of Frenkel excitons.[4]

Cr_2O_3 has the corundum structure with four chromium ions per rhombohedral unit cell.[7] Below 308°K the spins are antiferromagnetically aligned in chains along the threefold axis.[8] The site symmetry of the chromium ion is C_3 = 3, and using the international notation,[9] the symmetry of the magnetic lattice is described by the magnetic space group $R\bar{3}'c'$. Denoting the time-reversal operator by R, the operations of the space group are $\{E|0\}$, $2\{C_3|0\}$, $3\{C_2'|\vec{\tau}\}$, $\{RI|0\}$, $2\{RIC_3|0\}$, $3\{R\sigma_v|\vec{\tau}\}$, and the products of these with $\{E|\vec{R}_n\}$ and $\{\bar{E}|\vec{R}_n\}$. Here $\vec{\tau}$ is the nonprimitive translation $\frac{1}{2}(\vec{t}_1+\vec{t}_2+\vec{t}_3)$, and $\vec{R}_n$ is a lattice translation.

The selection rule for exciton absorption permits us to limit the discussion to excitons near the center of the Brillouin zone. These exciton states can be classified according to the