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We report preliminary results of a general technique for high resolution NMR of isotopically rare (13C, 15N, 2H, etc.) or chemically dilute spins in solids. The method combines established ideas of double resonance 1,2 and spin decoupling 3 in a novel way. It exploits abundant spins I, of abundance N_I and magnetic moment \( \gamma_I/\hbar \) (usually protons), present in the sample, as a reservoir of polarization for the rare spins S, to permit the accumulation of an adequately intense S-spin spectrum after a single polarization of the I spins to equilibrium. The general procedure is as follows: (1) Polarize I in high field. (2) Cool I to a low spin temperature in the rotating frame. (3) Establish I-S contact for a time T. (4) Record the S free induction decay while decoupling I. Steps 3 and 4 are repeated \( \sim N_I/N_S \) times during which the I polarization is depleted and the S signal accumulated. The spectrum is obtained by Fourier transformation. The repeated cross polarization (CP) of step 3 results in a gain in power sensitivity of \( G_{CP} \sim (N_I/N_S)(\gamma_I/\gamma_S)^2 \) over conventional Fourier transform spectroscopy. For \( S = ^{13}\text{C} \) and \( I = ^1\text{H} \) in typical organic compounds, \( G_{CP} \approx 10^3 \).

The expected gain has been verified in preliminary experiments using the natural abundance of \( ^{13}\text{C} \) in \( \sim 50 \) mg of solid adamantane, C_{10}H_{16} (Fig. 1). The spectrum of Fig. 1(c), recorded in 0.8 sec, is severely limited by the nonideal probe and receiver employed, and by magnetic inhomogeneity, but nonetheless demonstrates the power of the cross-polarization procedure. In natural abundance \( ^{13}\text{C} \) spectra we expect a residual S-S linewidth of the order of 5 Hz.4

Many versions of this method are clearly possible since the cooling, cross polarization, and decoupling can each be accomplished in several ways. In the

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The temperature was controlled by a flow of cooled or heated nitrogen gas in a thermostatic box with a thin cations. We report here thermodynamic constants, of aromatic hydrocarbons, only a little is known about reaction of monomer pyrene containing biphenyl in excess and that the relationship between the optical density and the concentration of pyrene is expressed by the equation
\[ \text{OD} = k_f \cdot [\text{Pyrene}] + k_b \cdot [\text{Pyrene}_{2}] + k_1 \cdot [\text{Pyrene}_{2}] . \]

The experimental apparatus and procedures for pulse radiolysis are described in the previous paper. The temperature was controlled by a flow of cooled or heated nitrogen gas in a thermostatic box with a thin aluminum window to admit the electron beam and a quartz evacuated cell as a window for the analyzing light beam.

Our previous study has shown that pyrene monomer cations are in equilibrium with pyrene dimer cations in irradiated oxygenated benzonitrile solutions of pyrene containing biphenyl in excess and that the relationship between the optical density and the concentration of pyrene is expressed by the equation
\[ 1/(D - D_0) = [1/(I - e_0) C_0] (1 + K[P]) , \]
where \( D \) is the observed optical density at the equilibrium state, \( D_0 \) is the optical density in the case that all the cation exists as the dimer cation, \( I \) is the optical...