calcite to the same extent. On the other hand, Fig. 1b shows that Mg^{++} ions influence the ζ potential of aragonite considerably less than Ca^{++} ions. Thus, Mg^{++} is adsorbed to a much lesser extent than Ca^{++} on the aragonite surface, while both ions are adsorbed on the calcite surface to a similar extent.

In view of these results and the observation that aragonite precipitates from solutions containing Mg^{++} and supersaturated with respect to both calcite and aragonite, it seems that adsorbed Mg^{++} slows down or probably even stops the growth of calcite nuclei.

Our findings may well explain the observations of Friedman[10] that recrystallization of aragonite and magnesium calcite to pure calcite is much slower in a marine environment than in a fresh water environment. They also support the suggestion recently made by Berner[11] that the diagenetic transformation of carbonate minerals in a marine environment is inhibited by the interaction of dissolved Mg^{++} ions with the surfaces of these minerals.

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Chemical Nomenclature

WOLFENDEN[1] emphasizes the trivial basis of the nomenclature of the elements. In a systematic system the elements need only be named by their atomic numbers. Numerical subscripts could be replaced by letters, for example, water would become 1_b8.

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PHYSICS

Einstein *A* Coefficient for the Λ Doublet Transitions of the Ground State of OH

FOR some time now there has been some uncertainty in the literature of the correct value for the Einstein *A* coefficients for the ground state Λ doublet transitions of OH. Barrett[1] calculated $A = 2.66 \times 10^{-11}$ sec^{-1} for the 1,667 Mc/s line using a matrix element $|\mu_{ij}|^2$ taken from Dousmanis, Sanders and Townes[2]. This element is incorrect both because the form of its dependence on the rotational quantum number J was incorrectly given as $[(J+1)(2J+1)]^{-1}$, and also because the element was incorrectly defined as (1). The appropriate definition is given below. The correct J-dependence, which is $[J(J+1)]^{-1}$, was given by Meyer[3], in connexion with the Stark-effect determination of the OH dipole moment, μ; because Meyer used an electric field directed so that only transitions of type $\Delta M_J = 0$ occurred between the magnetic sub-levels characterized by quantum number M_J, the problem of combining these elements with those for which $\Delta M_J = \pm 1$ to form an overall matrix element μ_{ij} was not encountered. To derive the overall matrix

element between the Λ doublet levels of the ground state of OH, Goss and Weaver[4] combined the correct J-factor of Meyer with standard relative intensity formulae for hyperfine transitions as given by Townes and Schawlow[5] to derive $A = 0.9640 \times 10^{-11}$ sec^{-1} for the 1,667 Mc/s line. They also used the most recent values for the OH dipole moment and the fine structure interaction constant, the calculation making use of the theory for intermediate coupling between Hunds's cases (a) and (b), as given by Dousmanis, Sanders and Townes[2].

I believe that the results of Goss and Weaver[4] are too small by a factor of eight, because the quantity $|\mu_{ij}|^2$ which they used is defined (p. 23, ref. 5) as

$$|\mu_{ij}|^2 = \sum_{M'_J} \{|\mu_x(JM_JJ'M_{J'})|^2 + |\mu_y(JM_JJ'M_{J'})|^2 + |\mu_z(JM_JJ'M_{J'})|^2\} \quad (1)$$

Because only one of the magnetic quantum numbers has been summed, this represents an average of the square of the matrix element for a transition from the lower state i to the upper state j, where in the present context these states are magnetic sub-levels. Because the net transition consists of the totality of Zeeman transitions between all such sub-levels making up each Λ doublet level, I believe the appropriate quantity is instead

$$|\mu_\Lambda|^2 = \sum_{M_J} \sum_{M'_J} \sum_{M_I} \sum_{M_{\bar I}} |<\Omega JIM_JM_I|\vec{P}|\Omega'JIM_{J'}M_I>|^2 \quad (2)$$

where the primes refer to final states, and I consider first the J,I,M_J,M_I representation of the electric dipole operator P. Ω represents all quantum numbers not involved in the transition.

Meyer[3] has given the matrix elements for $\Delta M_J = 0$, derived by using the fact that Λ doublet wave functions can be constructed from linear combinations of symmetric top wave functions, as shown by Wang[6]. I have derived in the same way the $\Delta M_J = \pm 1$ elements. The results for the $J \to J$ transition in Hunds's case (a) are

$$<\Omega^+JIM_JM_I|P|\Omega^-JIM_JM_I> = -\frac{\mu\Omega M_J}{J(J+1)}$$

$$<\Omega^+JIM_JM_I|P|\Omega^-JIM_J\pm1M_I> = -\frac{\mu\Omega\sqrt{((J\mp M_J)(J\pm M_J+1))}}{J(J+1)} \quad (3)$$

where $\Omega = \Sigma + \Lambda$ as usual, and Ω^+ and Ω^- refer to the symmetry of the wave function.

To carry out (2) I use equation (3) given by Condon and Shortley (p. 72, ref. 7), with $j \equiv J$, $m \equiv M_J$, $\alpha \equiv \Omega$, and with $<\Omega J|P|\Omega J> = \frac{-\mu\Omega}{J(J+1)}$ in their reduced matrix element notation. The result is

$$|\mu_\Lambda|^2 = (2I+1)(2J+1)\left[\frac{\mu^2\Omega^2}{J(J+1)}\right] \quad (4)$$

which with $I = 1/2$, $J = 3/2$ for the $^2\pi_{3/2}$ state of OH, is eight times larger than the $|\mu_{ij}|^2$ used by Goss and Weaver[4]. Thus

$$A_\Lambda = \frac{64\pi^4\nu_\Lambda^3}{3hc^3} \frac{|\mu_\Lambda|^2}{2J+1} = 17.06 \times 10^{-11} \text{ sec}^{-1}$$

is also eight times greater than the sum of the four hyperfine transition A's given by these authors.

The calculation can be repeated in the F, M_F, I, J representation, in which the matrix elements are derived by a transformation of those given in equation (3), following a procedure given by Condon and Shortley (ref. 7, pp. 63 and 69). Meyer[3] has given those for $\Delta M_F = 0$ and we add those for which $\Delta M_F = \pm 1$. The following results may have future use outside the present study.