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MULTIPLIERS OF H^p AND BMOA

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We characterize the multipliers from H^1 to X, where X is BMOA, VMOA, $\mathscr{B}$ or $\mathscr{B}_0$ and from H^p to H^q $(p < \min(q, 1))$. Also we give short proofs of some results of Hardy and Littlewood and Fleet.

I. Introduction. For $0 < p \leq \infty$, by H^p we denote the space of functions $f(z)$ analytic in the unit disk U, for which

$$M_p^p(r, f) = \frac{1}{2\pi} \int_0^{2\pi} |f(re^{i\theta})|^p \, d\theta$$

or

$$M_\infty(r, f) = \max_{0 \leq \theta \leq 2\pi} |f(re^{i\theta})|$$

remains bounded as $r \to 1$. Duren's book **[4]** and Garnett's book **[11]** will be frequently cited as a reference to H^p theory and related subjects.

Let A and B be two vector spaces of sequences. A sequence $\lambda = \{\lambda_n\}$ is said to be a multiplier from A to B if $\{\lambda_n \alpha_n\} \in B$ whenever $\{\alpha_n\} \in A$. The set of all multipliers from A to B will be denoted by (A, B). We regard spaces of analytic functions in the disk as sequence spaces by identifying a function with its sequence of Taylor coefficients.

Hardy and Littlewood **[14]** have proved the following theorem: If $1 \leq p \leq 2 \leq q$ and $p^{-1} - q^{-1} = 1 - \sigma^{-1}$ and if

$$M_\sigma(r, g') \leq c(1 - r)^{-1}, \qquad 0 < r < 1, \tag{1.1}$$

then $g \in (H^p, H^q)$ (c will be used for a general constant, not necessarily the same at each occurrence). Stein and Zygmund **[21]** (see also Sledd **[20]**) have observed that the condition (1.1) is also necessary in the case $p = 1$, $q \geq 2$. Hence the following theorem holds.

THEOREM HL. *Let $2 \leq q < \infty$. Then $g \in (H^1, H^q)$ if and only if*

$$M_q(r, g') \leq c/(1 - r), \qquad 0 < r < 1. \tag{1.2}$$