A topological space $X$ is called pseudo-$\aleph_1$-compact if every locally finite family of open sets in $X$ is countable. A topological space $X$ is called fairly pseudo-$\aleph_1$-compact if every family $\gamma$ of open sets in $X$ with $|\gamma| = \aleph_1$ has a complete accumulation point.

In section 2 is studied the following problem: Let $X$ be a Lindelöf $P$-space and $Y$ be a fairly pseudo-$\aleph_1$-compact space. Is the product $X \times Y$ fairly pseudo-$\aleph_1$-compact? It is proved that the product of a pseudo-$\aleph_1$-compact $P$-group and a fairly pseudo-$\aleph_1$-compact space is fairly pseudo-$\aleph_1$-compact.

In section 3 are studied $\tau$-stably and $\tau$-steady topological groups (see also section 5.6 in [A. Arhangel’skii and M. Tkachenko, Topological Groups and Related Structures, Hackensack, NJ: World Scientific; Paris: Atlantis Press (2008; Zbl 1323.22001)]). The main result is theorem 3.13: A Tychonoff space $X$ is $\tau$-stable if and only if the free topological group $F(X)$ is $\tau$-steady.

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MSC:

22A05 Structure of general topological groups
54H11 Topological groups (topological aspects)
54A25 Cardinality properties (cardinal functions and inequalities, discrete sub-sets)
54D20 Noncompact covering properties (paracompact, Lindelöf, etc.)

Keywords:
Lindelöf; free topological group; $R$-factorizable; $P$-space; weakly Lindelöf; $\tau$-stable; $\tau$-steady; pseudo-$\aleph_1$-compact; Tikhonov space

Full Text: DOI
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