The Loan Exhibit of the Aëronautical Society of Great Britain at the Milan Exhibition.

By arrangement with the British Commission of the Milan Exhibition, the Aëronautical Society of Great Britain has sent a loan collection of photographs, prints, diagrams, and other objects of Aëronautical interest, for exhibition in the Aëronautical Section of the Milan Exhibition.

The exhibit is largely representative of the recent work of members of the Aëronautical Society of Great Britain, and is illustrative of modern progress in the two departments of aëronautics which deal respectively with attempts to navigate the air by the body lighter than air—the balloon, and the body heavier than air—the aëroplane

The following are amongst the exhibits:

1.—Portraits. Major B. Baden-Powell (President, Aëronautical Society of Great Britain); Sir William Crookes, F.R.S.; James Glaisher; Henry Coxwell; Percy S. Pilcher, a British Martyr of the Air; some celebrities of the Paris International Congress, 1900, including Colonel F. C. Trollope, M. Jansson, M. Wilfred de Fonveille, M. Louis Triboulet, Mr. A. Lawrence Rotch (Director of the Blue Hill Observatory); Mr. Eric Stuart Bruce, M.A., Oxon. (Honorary Secretary, Aëronautical Society of Great Britain).

2.—Selected illustrations from the quarterly "Aëronautical Journal," published by the Council of the Aëronautical Society of Great Britain.

3.—Various prints from photographs of Major Baden-Powell's aëroplane experiments in 1904.

4.—Complete set of prints from photographs of the kites taking part in the International Kite Competition, organized by the Aëronautical Society of Great Britain, on the Sussex Downs in June, 1903.

5.—Prints from photographs of the paths of aërial gliders, illustrative of researches by Professor G. H. Bryan, F.R.S., and diagrams of the longitudinal stability of aëroplanes.

6.—Stereoscopic view of the British war balloon, ready to ascend during Lord Roberts' advance to Pretoria, in the South African war, mounted in stereoscope.

7.—Photograph of an aluminium airship.

8.—Photographs and diagram of Mr. Hitchcock's toboggan gliders at Montreal.

10.—Photographs of the de Bradsky airship.

11.—Photographs of Dr. Hutchinson's bird-like flying machine.

12.—Photographs of Mr. Alexander Burgoyne's aluminium kite.

13.—Photograph of Mr. Wilson Fox's kite.

14.—Photograph of Mr. W. H. Salmon's rhomboidal kite.

15.—Photographs of box kite and winding gear used in Mr. Bruce's Scottish Antarctic Expedition, 1902.

16.—Photographs of Mr. Zimmerman's cycala flying machine.

17.—Prints of airships at the St. Louis Exhibition, 1904.

18.—Charts, showing wind forces as taken on the Eiffel Tower, on the days of M. Santos Dumont's navigable balloon experiments in 1901.

19.—Prints of experiments with Major Baden-Powell's man-lifting kite.

20.—Prints from photographs of the Bacon and Maskelyne hot-air balloon.

21.—The altimeter (actual instrument), for taking observation of the highest altitude reached by kites and balloons invented by Messrs. Newton and Co.

The Late Professor S. P. Langley.

(By the Editor.)

By the death of Professor S. P. Langley aëronautics has not only lost one of its most steadfast workers, but one who, by his elucidation of some of its most difficult problems, did more than any other man has done to show that human flight was no chimera, but a scientific possibility. It might well be asked whether if Langley had not lived there might not still exist much of the old prejudice against the student of aëronautics, a prejudice, which called him a dreamer, and dulled even the eyes of men of light and learning.

Samuel Pierpoint Langley was born at Roxburg, Massachusetts, August 22nd, 1834. After graduating from the Boston Latin School, he devoted himself at first to civil engineering, and then to architecture. He soon, however, abandoned these professions to devote himself to astronomy. It was, indeed, as an astronomer that Professor Langley was generally known, though in the mind of the aëronautical student his achievements with the aëroplane is his most prominent work.

In 1863 he went to Europe, and there visited foreign observatories and scientific institutions, and on his return to America in 1865, became an assistant in the Harvard Observatory, where he only remained a few months, being appointed Professor of mathematics in the United States Naval Academy of Annapolis, in 1866. In the same year he was appointed Professor of Astronomy in the Western University of Pennsylvania, at Pittsburg, where he remained until 1887. In that year he was appointed assistant secretary of the Smithsonian Institution at Washington. Before the close of the same year he had succeeded to the full secretaryship of that important institution, a post which he retained until the day of his death. It was in connection with that institution that he displayed his remarkable powers of organisation and administration. In an excellent notice of his scientific work, which appeared in the pages of *Nature,* on March 8th last, will be found a *resume* of the principal features of his connections with the Smithsonian Institution. How he founded the children's room in its museum; how the long-established Bureau of American Ethnology flourished vigorously under his care, until it assumed "magnificent proportions"; how he established a Zoological Park containing the wild animals of his native land.

Professor Langley accompanied many of the parties sent out by the United States Government to observe eclipses in various parts of the world. In connection with his astronomical work must be mentioned his faithful drawings of the solar surface, his writings on the physical constitution of the sun, his spectroscopic studies, and his invention of the bolometer, a sensitive instrument for measuring minute changes in heat, an instrument which has been of the greatest value in increasing our knowledge of the infra red of the spectrum.

But it is the aëronautical work of the lamented physicist that claims the chief attention of these pages.

From boyhood, Langley had been interested in aërial flight, but took up the subject seriously in 1889. In 1891, Langley published his "Experiments in Aërodynamics," a work which proved a corner-stone in aëronautical progress. In this work it is conclusively shown that with means actually possessed we have the power to sustain and propel in air bodies which are heavier than air. Further than this, that if in such aërial motions there is given a plane of fixed size and weight, inclined at such an angle, and moved forward at such a speed that it shall be sustained in horizontal flight, then the more rapid the motion is, the less will be the power required to support and advance it.

The experiment by which Langley arrived at this conclusion may be described as a classical one. It was undertaken at Pittsburg, when he was Professor of the Astronomical Observatory there. In his laboratory, built for aërial investigations, he had provided a whirling table—an arm, 30 feet long, which swung about on a central pivot, 10 feet above the ground. It was rotated by a 10-horse power steam engine, and it went round at all speeds up to seventy miles an hour. On the end of the arm were instruments that measured the lifting power of the wind upon any inclined surface hung on them. When a spring scale, to which brass plates were attached, hung there it was found that the faster the arm rotated, the less weight the plates registered on the scales until at great speeds they almost floated in the air. The higher the speed, the less was the force required to keep the plates from falling.

After carrying out the experiments described in the above-mentioned work, the Professor says he was convinced that the obstacles in the way of attaining aërial navigation were not so great as have been thought, and that they lie more in such apparently secondary difficulties as the power of guiding the body so that it may move in the direction desired, and ascend or descend with safety, than in what may appear to be the primary difficulties due to the nature of the air itself.

In 1893, Langley produced his celebrated paper on "The Internal Work of the Wind." This was written to show the reason why certain species of birds maintain themselves indefinitely in the air by soaring without any flapping of the wing, or any motion other than a slight working of the body.

No satisfactory mechanical explanation of this anomaly had been given before this work was published.

That the ability to soar was in some way connected with the presence of the wind was, to the writer, as certain as any fact of observation could be, though at first, the difficulty of reconciling such facts with accepted laws of motion seemed quite insuperable.

We are told that light came to him through one of those so-called accidents which are commonly found to occur when the mind is intent on a particular subject, and looking everywhere for a clue to its solution. In 1887, while engaged with the whirling table in the open air, at the Allegheny Observatory, he had chosen a quiet afternoon for certain experiments, but in the absence of the entire calm which is almost never realized, had placed one of the very small and light anemometers, made for hospital use, in the open air, with the object of determining and allowing for the velocity of what feeble breeze existed. His attention was called to the extreme irregularity of this register, and he assumed at first that the day was more unfavourable than he had supposed. Subsequent observations, however, showed that when the anemometer was sufficiently light and devoid of inertia, the register always showed great irregularity, especially when its movements were noted, not from minute to minute, but from second to second.

When Langley's attention was once aroused to these anomalies, he was led to reflect upon their extraordinary importance in a possible mechanical application. He designed certain special apparatus, with which he made observations which showed that the wind in general was not what it was commonly asserted to be, that is, air put into motion with an approximately uniform velocity, in the same strata; but that, considered in the narrowest practical section, wind is always not only approximately uniform, but variable, and irregular in its movement beyond anything which had been anticipated, so that it seemed probable that the smallest part observable could not be treated as approximately homogeneous, but that even here there was an internal motion to be considered distinct from that of the whole body, and from its immediate surroundings. It seemed to follow as a necessary consequence that there might be a potentiality of what might be called internal work in the wind. On further study it seemed to him that this internal work might conceivably be so utilized as to furnish a power which should not only keep an inert body from falling, but cause it to rise, and while this power was the probable cause of the action of the soaring bird, it might be possible through its means to cause any suitably disposed body, animate or inanimate, wholly immersed, and wholly free to move, to advance against the direction of the wind itself.

But Langley was much more than a theorist. In 1896, he constructed his steam-driven flying models, called aërodromes, and made almost entirely of steel. One of these accomplished the longest flight then known for a flying machine, more than three-quarters of a mile, over the Potomac River. The apparatus consisted of two pairs of wings and a tail, with two screw propellers driven by a high pressure engine of 1-horse power, and weighing 7 lbs. The apparatus alighted safely after each of the three flights made. The lift per horsepower was not high, for a variety of reasons, but the stability was very good. In fact, on the occasion of the most successful flight, the machine is described as darting forth from its launching stage and travelling in an almost straight line through the air for over three-quarters of a mile. Langley called his models aërodromes instead of aëroplanes, as such a name was more applicable to arched surfaces, which are more efficient than plane surfaces.

Thus does Langley describe the first flight of the aërodrome, after the first desultory experiments: "On the 6th of May of last year, I had journeyed, perhaps for the twentieth time, to the distant river station, and recommenced the weary routine of another launch, with very moderate expectations, indeed; and when on that, to me, memorable afternoon the signal was given and the aërodrome sprang into the air, I watched it from the shore with hardly a hope that the long series of accidents had come to a close; and yet it had, and for the first time the aërodrome swept continuously through the air like a living thing, and as second after second passed on the face of the stop watch, until a minute had gone by, and it still flew on; and as I heard the cheering of the few spectators, I felt that something had been accomplished at last, for never in any part of the world or in any period had any machine of man's construction sustained itself in the air before for even half of this brief time. Still, the aërodrome went on in a rising course, until at the end of a minute and a half, for which time only it was provided with fuel and water, it had accomplished a little over half a mile, and now it settled, rather than fell, into the river with a gentle descent."

For a still fuller description of the flight of Langley's aërodrome, the reader is referred to the January number of this Journal, 1897.

It will suffice here to quote the following technical details of the 1896 machine:

Length from tip to tip .	12 feet.
Surface	70.0 sq. ft.
Weight	72.00 lb.
Pounds per S. F. . .	0.43
Speed per hour . .	24 miles
Maximum Flight . .	4,000 feet
Horse Power . .	1.00
Pounds sustained per H.P.	30
Motive Power . .	Steam

Langley had become too much inspired with confidence in the ultimate triumph of the heavier than air principle to be content with working models, and his later efforts were vigorously directed to the production of a motor-driven aëroplane that would carry a human being. It is well known that these more ambitious projects were not crowned with the success he had hoped to secure, but, as he has pointed out, they could not be described as failures, for the very reason that it was the launching apparatus which failed, the aëroplane never having been in the air at all. So whether or no Langley was on the border of success, or further from it than he reckoned, cannot be said, anyhow, those who have read his pamphlet, lately published, and entitled "Experiments with the Langley Aërodrome (Smithsonian Report for 1904"), must feel convinced that had the great investigator been able to continue the experiment, which was stopped for want of funds, the launching difficulties would, at any rate, have been overcome, and a just estimate have been formed of the capabilities of the machine.

The following particulars concerning his recent experiments may be of interest.

In the above-mentioned work, Professor Langley thus described how his work with models developed into the experiments with the large-sized man-carrying machine: "In the early part of 1868, a board composed of officers of the army and navy was appointed to investigate these past experiments, with a view of determining just what had been accomplished, and what the possibilities were of developing a large-sized man-carrying machine for war purposes. The report of this board being favourable, the Board of Ordnance and Fortification of the War Department decided to take up the matter, and I, having agreed to give, without compensation, what time I could spare from official duties, the Board allotted 50,000 dollars for the development, construction, and test of a large aërodrome, half of which sum was to be available immediately, and the remainder when required. The whole matter had previously been laid before the Board of Regents of the Smithsonian Institution, who had authorised me to take up the work, and to use in connection with it such facilities of the Institution as were available."

One of the greatest difficulties encountered in the construction of the large machine was the engine. Langley searched all over America for an adequate one. Disappointed in his search there, he went to Europe to personally visit large builders of engines for automobiles, and to try and persuade some maker to undertake the construction of such an engine as was required. "This search was, however, fruitless, as all of the foreign builders, as well as those of this country, believed it impossible to construct an engine of the necessary power, and so light as I required (less than 10 pounds to the horse-power, without fuel or water). I was, therefore, forced to return to this country and to consent most reluctantly, even at this late date, to have the work of constructing suitable engines undertaken in the shops of the Smithsonian Institution."

The following is Langley's own description of the essential features of the man-carrying machine:

"The flying weight of the machine complete, with that of the aëronaut, was 830 pounds, its sustaining surface 1,040 square feet. It therefore was provided with slightly greater sustaining surface, and materially greater relative horse-power than the model subsequently described, which flew successfully. The whole horse-power of the engine was 52; the engine itself, without cooling water or fuel, weighed approximately 1 kilogram to the horse-power. The entire power plant, including cooling water, carburettor, battery, etc., weighed materially less than 5 lbs. to the horse-power. Engines for both the large machine and the quarter size model were completed before the close of 1901, and they were immediately put in their respective frames, and tests of them and their power-transmission appliances were begun. It is well here to call attention to the fact that although an engine may develop sufficient power for the allotted weight, yet it is not at all certain that it will be suitable for use on a machine which is necessarily so light as one for traversing the air, for it would be impossible to use, for instance, a single cylinder gasoline engine in a flying machine, unless it had connected to it prohibitively heavy fly-wheels. These facts being recognised, the engines built in the Smithsonian shops were provided with five cylinders, and it was found upon test that the turning effect received from them was most uniform, and that by suitable balancing of rotating and reciprocating parts they could be made to work so that there was practically no vibration even when used in the very light frames of the aërodromes.

"The engine is not all the apparatus connected with the development and delivery of power, for obviously there must be shafts, bearings, and in the present case there were also gears; and all of these parts must necessarily be phenomenally light, while all of the materials must be capable of withstanding repeated and constant strains far beyond their elastic limit. It is also evident to anyone having familiarity with such constructions, that it is most difficult to keep the various bearings, shafts, gears, etc., in proper alignment without adding excessive weight, and also that when these various parts once get out of alignment when subject to strain, the disasters which are caused render them unfit for further use.

"The engines themselves were successfully completed before the close of 1901, and were of much more power than those originally designed, but nearly a year and a half had been spent not only in their completion, but in properly co-ordinating the various parts of the frame carrying them, repairing the various breakages, assembling, dismounting, and reassembling the various parts of the appliances, and in general rebuilding the frame and appurtenances to correspond in strength to the new engines.

"There are innumerable other details, for the whole question is one of details. I may, however, particularly mention the carburettors, which form an essential part of every gas engine, and such giving fair satisfaction for use in automobiles were on the market at the time, yet all of these failed to properly generate gas when used in the tests of the engine working in the aërodrome frame, chiefly because of the fact that the movement of the engine on this light frame must be constant and regular or the transmission appliances are certain of distortion. It was, therefore, necessary to devise carburettors for the aërodrome engines which would meet the required conditions, and more than half a dozen were constructed, which were in advance of anything then on the market, and yet were not good enough to use in the aërodrome before a satisfactory one was made. These experiments were made in the shop, but with an imitation of all the disturbing influences which would be met with in the actual use of the machine in the air, so as to make certain, as far as possible, that the first test of the machine in free flight would not be marred by mishaps or unseen contingencies in connection with the generation and use of power."

In giving these details, Langley well pointed out that only those who are initiated in such experiments can appreciate the delays which must be experienced in carrying out such experiments. But in conducting such experiments delay is prudence. How many are the experimenters in aëronautics who have pushed on their experiments in over eagerness to put their inventions to the test, without waiting for the missing link, in the absence of which the truly scientific mind refuses to proceed? How many, in consequence of undue haste have met with disaster and death? Langley states that it was only in the spring of 1903, after two years of assiduous labour, that the engines and their appurtenances, weighing altogether less than 5 pounds to the horse-power, and far lighter than any known to be then existing, were so co-ordinated and adjusted, that successive shop tests could be made without causing injury to the frame, and its bearings, shafts, or propellers.

As at the time mentioned above, all appeared to be ready for immediate experiment, the large aërodrome and quarter size counterpoint for preliminary experiments, were placed on board a large houseboat, and the whole was towed to a point in the Potomac River, 3 miles wide, directly opposite Wide Water, Virginia, and about 40 miles below Washington, and midway between the Maryland and Virginia shores, where the boat was made fast to moorings which had previously been placed in readiness for it.

"Before the test was made, many delays were encountered owing to storms and other circumstances, but on the 7th October, 1903, the long-awaited experiment was made. In this, the first test, the engineer took his seat, the engine started with ease and was working without vibration, at its full power of over 50-horse, and the word being given to launch the machine, the car was released and the aërodrome sped along the track. Just as the machine left the track, those who were watching it, among whom were two representatives of the Board of Ordnance, noticed that the machine was jerked violently down at the front (being caught, as it subsequently appeared, by the falling ways), and under the full power of its engine was pulled into the water, carrying with it its engineer. When the aërodrome rose to the surface, it was found that while the front sustaining surfaces had been broken by their impact with the water, yet the rear ones were comparatively uninjured. As soon as a full examination of the launching mechanism had been made, it was found that the front portion of the machine had caught on the launching car, and that the guy post, to which were fastened the guy wires, which are the main strength of the front surfaces, had been bent to a fatal extent. The machine then had never been free in the air, but had been pulled down."

The second and last attempt was made on December 8th, 1903. "The engine being started, and working more satisfactorily, the order was given by the engineer to release the machine, but just as it was leaving the track, another disaster, again due to the launching ways, occurred. This time, the rear of the machine in some way still unexplained, was caught by a portion of the launching car, which caused the rear sustaining surface to break, leaving the rear entirely without support, and it came down almost vertically into the water. Darkness had come before the engineer, who had been in extreme danger, could aid in the recovery of the aërodrome. The boat and machine had drifted apart, and one of the tugs, in its zeal to render assistance, had fastened a rope to the frame of the machine in the reverse position from what it should have been attached, and had broken the frame entirely in two."

The damage done to the machine by this accident was by no means irreparable, in fact, it is stated that while in the shop many test accidents had occurred of far more serious nature, causing greater damage, and requiring more time for repairs, but what was more serious for the immediate progress of aërial navigation, was the collapse of the funds specially provided for test experiments, and the impossibility of securing others for continuing the work. Thus did Langley sum up the situation:

"There have, then, been no failures as far as the actual test of the flying capacity of the machine is concerned, for it has never been free in the air at all. The failure of the financial means for continuing these expensive experiments has left the question of their result where it stood before they were undertaken, except that it has been demonstrated that engines can be built, as they have been, of little over one half the weight that was assigned as the possible minimum by the best builders of France and Germany; that the frame can be made strong enough to carry these engines, and that, so far as any possible prevision can extend, another flight would be successful if the launching were successful, for in this, and in this alone, as far as is known, all the trouble has come."

To Langley, it has not been granted to see the completion of his work, and it is for others to follow in his footsteps. There may be those who, on his work, may find cause to vary and modify details of his construction; but they may well follow the general principles which guided his method of researches —to submit all the workings of the mind to the rigid test of experiment, and not to neglect the preliminary laboratory investigations, where are laid sure foundations, on which to build up larger projects.

For the following details concerning Professor Langley's writings, and the honours at home and abroad which he received, the writer is indebted to the courtesy of the present acting secretary of the Smithsonian Institution.

Langley's published writings include over one hundred titles. He was Foreign Member of the Royal Society of London, a correspondent of the Institute of France, Fellow of the Royal Astronomical Society of London, Member of the Royal Institution of London, Member of the Academia dei Lincei of Rome, of the National Academy of Sciences, and of many other Institutions.

He received the degree of D.C.L., from Oxford, D.Sc., Cambridge, and among numerous others, the degrees of LL.D. from the Universities of Harvard, Princeton, Michigan, and Wisconsin. He was awarded the Henry Draper Medal by the National Academy of Sciences, the Rumford Medal, by the Royal Society of London, and the Rumford Medal by the American Academy of Arts and Sciences, as well as the Janssen Medal from the Institute of France, and the Medal of the Astronomical Society of France.

Many of Mr. Langley's public works had great literary charm, more especially the New Astronomy, which was based originally upon a series of Lowell lectures, that afterwards appeared in serial form in the *Century Magazine*. In general, few of his writings were couched in technical language, for, however, abstruse the subject, they were written so that they could be appreciated. He was firmly convinced that scientific writing could be made accessible to the public if sufficient pains were taken by the author, and in many of his papers, as well as in the work alluded to, he successfully attained this end.

He had a deep interest in all that related to things of the mind, and was for many years associated with both the American and British Associations for Psychical Research. He was an omnivorous reader of everything that was best in English and French literature, and was especially interested in George Borrow. He was the owner of a considerable collection of Borrow's manuscripts, and was a student of French history and memoirs. His interest in the fine arts was keen, and he had many times visited the galleries of Europe, and knew the great pictures everywhere. The Orient had a fascination for him, and he had a collection of the editions of the "Arabian Nights." As a young man, he was a great admirer of Thomas Carlyle, with whom he had an acquaintance, and to whose home he made several pilgrimages. He had a great love for little children, and the "Children's Room" in the Smithsonian building, mentioned above, was the result of his personal attention.

A last word in memory of Professor Langley may be added from personal acquaintance of the writer. Not least amongst the charms with which the great investigator was endowed was his intense modesty of character. Another charm was, perhaps, his sympathy with the work of others, even if that work was not in those directions in which his own mind had its bent.

The Experiments of the Brothers Wright.

As is notified in another part of this Journal, no less an authority than Sir Hiram Maxim has promised to address the members of the Aëronautical Society of Great Britain, on the subject of the recent experiments of the Brothers Wright, at the meeting of the Society on April 27th next. Many remarks on these experiments will therefore be now deferred. It may, however, be here stated that various reports which have come to hand seem to confirm the statements made by the Brothers Wright in the letter which was read to the members of the Aëronautical Society of Great Britain, at the opening meeting of the present session.

Our contemporary, *L'Aerophile*, in its January issue, has published many interesting statements obtained from various sources, concerning these remarkable experiments which may be the commencement of a new era in aërial navigation. The following details derived from *L'Aerophile*, and various other sources, may be of interest to our readers, though in the absence of the precise information which is still withheld by the experimenters, no responsibility for the accuracy of these details can be taken. Conflicting statements as to some of these details must also be regarded as a sign that full confirmation must be awaited before assigning them to the history of aërial navigation. As far as can be gathered from accounts received, the frame of the machine which in form is evidently very similar to the older double-decked gliding machines of Messrs. Wright, and familiar to our readers, is made of larch wood. From tip to tip of the wings, its length is 40 feet, its breadth in the widest part is only six feet. The frame is covered with canvas. The gasoline motor, is stated in some accounts, to be 15-horse power, in others, 21-horse power. The total weight of the machine is 925 lbs., that of the motor alone, 40 lbs. The operator lies face downwards, in a horizontal position on the lower plane, and as close to the frame as possible. Since a weight hanging below the centre of gravity, like a pendulum, causes the aëroplane to capsize, all weight has to be concentrated as near as possible in a common plane. As to the steering apparatus, there is some discrepancy in the accounts. Some describe