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The present invention relates to spectrum measuring equipment which can be used with a spectrum analyzer, for instance.

The spectrum analyzer or similar spectrum measuring apparatus employs a prism, diffraction grating, or like dispersing element for separating light to be measured into its spectral components (wavelength components) of respective wavelengths.

Fig. 1 shows in section the structure of a diffraction grating 14, which has about ten to hundreds of equally-spaced-apart minute grooves U per millimeter cut in the surface of sheet glass. When light to be measured Q, which has an optical axis in a plane perpendicular to the grooves U (i.e. in the plane of the paper of the drawing), is incident to the diffraction grating 14, wavelength components of wavelengths $\lambda_1$ and $\lambda_2$, for example, contained in the light Q, are dispersed and reflected in the direction of arrangement of the grooves U in the above-mentioned plane. The angles of dispersion, $\theta_1$ and $\theta_2$, of the light waves are dependent upon their wavelengths $\lambda_1$ and $\lambda_2$. In the following description the direction of change, D, in the angle of dispersion with wavelength will be referred to as the direction of separation of light and each angle in the direction D as an angle of separation of light, i.e. an angle of diffraction. Consequently, the direction of light separation D is in the plane of the paper of the drawing Fig. 1.

The quantities of light of the wavelengths $\lambda_1$ and $\lambda_2$ thus dispersed or separated are measured by scanning a photodetector 16 in the direction of light separation D relative to the diffraction grating 14. The wavelength distribution of light is obtained by detecting the levels of the received light signals developed at the positions of respective angles of light separation when the photodetector 16 is scanned in the direction of light separation D. The scanning of the photodetector 16 relative to the diffraction grating 14 in the direction of light separation D may be done by turning the diffraction grating 14 or moving the photodetector 16 in the direction D. It is customary in the art to turn the diffraction grating 14 in the direction of light separation D about a straight line O1 parallel to the grooves U.

Incidentally, the dispersing element such as a diffraction grating has a shortcoming that when the light to be measured Q incident thereto is polarized light, the diffraction efficiency varies with the angle of its plane of polarization, causing a change in the quantities of light of the wavelengths $\lambda_1$ and $\lambda_2$ to be dispersed or separated. This phenomenon is commonly referred to as a polarization dependency of the dispersing element.

Fig. 2 shows the polarization dependency characteristic of the diffraction grating. The curve $g(\lambda)$ represents the diffraction efficiency for the light wave of each wavelength in the case where the plane of polarization of the incident light is parallel to the direction of light separation D, i.e. where the plane of polarization is perpendicular to the grooves U of the diffraction grating 14. The curve $f(\lambda)$ represents the diffraction efficiency for the light wave of the wavelength in the case where the plane of polarization of the incident light is perpendicular to the direction of light separation D, i.e. where the plane of polarization is parallel to the grooves U of the diffraction grating 14. What is meant by the two curves $g(\lambda)$ and $f(\lambda)$ is that when the plane of polarization of light incident to the diffraction grating has turned from the direction parallel to the direction of light separation D to the direction perpendicular thereto, the diffraction efficiency varies from the curve $g(\lambda)$ to $f(\lambda)$, that is, the level of diffracted light at each wavelength varies accordingly. As will be seen from Fig. 2, the diffraction grating has no polarization dependency only at a wavelength $\lambda_0$ but has the polarization dependent characteristics at other wavelengths. In the case of measuring light emitted from an optical fiber, the influence of variations in the diffraction efficiency of the dispersing element is particularly great, because the plane of polarization of the emitted light has undergone substantial variations according to the state of the optical fiber.

In Japanese Patent Application Laid Open No. 28623/87 there is proposed spectrum measuring equipment which has solved the above problem. The spectrum measuring equipment disclosed in that publication has an arrangement in which the light to be measured is dispersed or separated by a dispersing element, the dispersed light is split by a polarizing element into polarized light components P and S whose planes of polarization are perpendicular to each other, the P and S polarized components are applied to two different photodetectors to obtain electric signals corresponding to the quantities of light of the P and S polarized components, and based on the electric signals, the diffraction efficiencies Ap and Bs of the polarized components P and S in the dispersing element, the loss ratios Cp and Ds of the polarized components P and S in the polarizing element and the photoelectric conversion efficiencies L1 and L2 of the photodetectors, stored in a memory for each wavelength, are read out for obtaining the absolute power of the light Q through calculation. With this conventional spectrum measuring equipment, it is possible to avoid the influence of the change in the diffraction efficiency owing to the difference in angle between the planes of polarization in the dispersing element. To perform this, however, it is necessary to prestore in the memory correction data such as the diffraction efficiencies Ap and
Bs of the dispersing element for the polarized components P and S, the loss ratios Cp and Ds for the polarized components P and S in the polarizing element, and the photoelectric conversion efficiencies L1 and L2 of the photodetectors. Since the correction data is needed for each wavelength, an appreciable amount of data must be prepared for measurement with high resolution. Further, since the data differs in value with products, the preparation of such data is time-consuming and hence introduces complexity in the fabrication of equipment. Moreover, since there are cases where the measurement of spectrum may sometimes be subject to the influence of variations in the diffraction efficiency according to the values of the correction data stored in the memory, the polarization dependency of the dispersing element cannot always be eliminated.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide spectrum measuring equipment which permits elimination of the polarization dependency of the dispersing element without the necessity of prestoring various kinds of correction data in a memory.

The spectrum measuring equipment of the present invention is made up of a double-image polarizing element for splitting light to be measured into two polarized light components which have their planes of polarization orthogonal to each other and have different optical axes, a dispersing element which is irradiated by the two polarized light components with their planes of polarization intersecting the direction of light separation at angles of ±45° thereto, respectively, and whereby each of the two polarized light components is separated into individual wavelength components, components of the same wavelength in the two polarized light components having the same angle of separation, and light-quantity measuring means for measuring the sum of the quantities of light of the two polarized light components of the same wavelength separated by the dispersing element.

According to the present invention, since the light to be measured is applied to the dispersing element after being split into two polarized light components so that their planes of polarization cross the light-separating direction of the dispersing element at ±45° thereto, the diffraction efficiencies for the two polarized light components are equal. Hence, even if the plane of polarization of the light to be measured changes, the powers of the two polarized light components vary complementarily and their sum always remain constant. In consequence, the polarization dependency of the dispersing element can be removed by obtaining the sum of the optical powers of spectral components of the same wavelength in the two polarized light components. Thus, the present invention permits elimination of the polarization dependency of the dispersing element without involving the necessity of using the afore-mentioned correction data and offers simple-structured, easy-to-manufacture spectrum measuring equipment. Besides, since no correction data is needed, no limitations are imposed on resolution for the direction of wavelength -- this allows highly accurate spectrum measurements.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view of the structure of a dispersing element, for explaining its operation;
Fig. 2 is a graph for explaining the polarization dependency of the dispersing element;
Fig. 3 is an optical diagram illustrating an embodiment of the present invention;
Fig. 4 is a side view explanatory of the operation of a double-image polarizer used in the present invention;
Figs. 5A, 5B, 5C and 5D are front views of the double-image polarizer, for explaining its operation;
Fig. 6 is a diagram for explaining beams and their optical axes from a light source 11 to a dispersing element 14;
Fig. 7 is a front view for explaining how the dispersing element used in this embodiment is irradiated with two polarized light waves;
Fig. 8 is a graph for explaining the operation of the present invention;
Fig. 9 is an optical diagram illustrating a second embodiment of the present invention;
Fig. 10A is a side view of a double Wollaston prism;
Fig. 10B is its plan view; and
Figs. 11A and 11b are its front views for explaining its operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 3 illustrates an embodiment of the present invention. Reference numeral 11 indicates a light source for emitting light to be measured. In this embodiment the light is shown to be transmitted over an optical fiber 10.

Reference numeral 12 denotes a double-image polarizing element upon which the light emitted from the
light source 11 is incident and wherein the light is split into two polarized light components whose planes of polarization perpendicularly cross each other. The double-image polarizing element 12 has a function of separating the incident light to two beams of different optical axes as well as the function of splitting the light into the above-mentioned two polarized wave components. Such a double-image polarizing element is presently available in the commercial marketplace. An example of the double-image polarizing element is a Savart plate. The Savart plate has a structure in which two plane-parallel plates 12a and 12b of exactly the same thickness, each produced by cutting crystal, calcite, or similar uniaxial crystal obliquely to its crystal axis, are pasted together, with their principal sections turned 90° apart as shown in Fig. 4.

An ordinary ray 22 in the first plate 12a of the Savart plate becomes an extraordinary ray 24 in the second plate 12b, whereas an extraordinary ray 23 in the first plate 12a becomes an ordinary ray 25 in the second plate 12b. Hence, by the passage of the two polarized components through the first and second plates 12a and 12b, their optical axes are once displaced laterally in parallel at right angles to each other, that is, the incident light 21 is separated into two rays 24 and 25 polarized perpendicularly to each other.

Figs. 5A, 5B, 5C and 5D show how the above phenomenon occurs. Fig. 5A shows arbitrarily polarized light 21 incident to the first plate 12a. Fig. 5B shows the relationship between the ordinary ray 22 incident to the second plate 12b from the first plate 12a and the laterally displaced extraordinary ray 23 at the boundary between the first and second plates 12a and 12b. Fig. 5C shows the relationship between the ordinary ray 25 of the polarized light 23 incident to the second plate 12b and the laterally displaced extraordinary ray 24 of the polarized light 22 incident to the second plate 12b, the arrows indicating the directions of polarization. Turning Fig. 5C through 45°, for example, clockwise in the plane of the paper, the polarized rays are displaced in the vertical direction as shown in Fig. 5D, and as a result of this, two beams 24 and 25 are obtained which are of parallel optical axes and which have polarization direction at ±45° with respect to the vertical axis Z, respectively.

In Fig. 3 the double-image polarizing element 12 is shown to be disposed so that its Z axis shown in Fig. 5D is parallel to the center axis of rotation, O0, of the dispersing element 14. In Figs. 5A through 5D the beams 22 and 23 and the beams 24 and 25 are shown to be spaced apart, but in practice, their lateral displacement is small as compared with their diameters and the beams 24 and 25 substantially overlap each other.

The two polarized rays 24 and 25 split by the double-image polarizing element 12 are each reflected by a collimator mirror 13 into parallel rays for incidence to the dispersing element 14.

To facilitate a better understanding of the embodiment depicted in Fig. 3, Fig. 6 shows an optical system in which the light source 11, the double-image polarizing element 12, a collimator lens 13' as a substitute for the collimator mirror 13 in Fig. 3 and the dispersing element 14 are arranged in this order on a straight line, the optical system being shown in its section along its optical axis Ox and parallel to the center axis of rotation, O0, of the dispersing element 14. The beam 21 emitted from the light source 11 disposed at the focal point of the collimator lens 13 is incident to the double-image polarizing element 12, from which the two polarized beams 24 and 25 having their planes of polarization tilted at ±45° to the Z axis, as described above in respect of Fig. 5D, are emitted while being displaced from each other in the Z-axis direction. The beams 24 and 25 are indicated by the broken line and the solid line, respectively, so that they are readily distinguishable from each other. The center axes 24A and 25A of these polarized beams 24 and 25 are parallel to the optical axis Ox. The polarized beams 24 and 25 are collimated by the collimator lens 13' into two parallel beams to each other and then are incident on the dispersing element 14, but as shown in Fig. 6, the center axes 24A and 25A of the parallel beams 24 and 25 are in the plane containing the Z axis and the optical axis Ox, and cross each other on the focal plane of the collimator lens 13'. That is, when the dispersing element 14 is not on the focal plane of the collimator lens 13', for example, when it is disposed far from the focal plane thereof, the polarized beams 24 and 25, which are incident to, for example, the grating surface of a diffraction grating used as the dispersing element 14, are shifted from each other in the Z-axis direction, i.e. in the direction of extension of the grooves U as shown in Fig. 7.

By splitting the light from the same light source 11 by the double-image polarizing element 12 into the two polarized beams 24 and 25 of different optical axes, the two beams 24 and 25 can be handled essentially as beams emitted from two different light sources 11a and 11b as depicted in Fig. 6. Accordingly, even if the two beams 24 and 25 propagate in the same space, or even if they overlap each other on the same surface area of the collimator mirror 13, the dispersing element 14, or a converging mirror 15 and are reflected therefrom, their polarization properties are retained. Consequently, the two polarized beams 24 and 25 are individually separated into their spectral components (wavelength components) by the dispersing element 14 and the separated beams are converged by the converging mirror 15, thereafter being applied through a slit 17 to the photodetector 16 such as a photodiode.

The width of the slit 17 is selected dependent on the wavelength resolution required of the spectrum measuring equipment. On the other hand, the height of the slit 17 (the length in the Z-axis direction) is desired to
be as small as possible from the viewpoint of shielding the photodetector 16 from stray light. In practice, however, it is difficult to form the slit 17 so that it cuts out in the Z-axis direction the two polarized beams 24 and 25 shifted from each other in the Z-axis direction without changing the ratio of their quantities of light at all times. It is therefore necessary to select the height of the slit 17 so that the polarized beams 24 and 25 condensed by the converging mirror 15 shown in Fig. 3 pass through the slit 17 without being cut out in the Z-axis direction perpendicular to the direction of light separation.

In Fig. 3, letting the focal distance of the collimator mirror 13, the focal distance of the converging mirror 15 and the height of an object in the Z-axis direction disposed on the focal plane of the collimator mirror 13 (on which the light emitting end of the light source 11 is placed in Fig. 3) be represented by \( f_1, f_2 \) and \( Y_{o} \) respectively, the height \( Y_1 \) in the Z-axis direction of an image of the object which is formed on the focal plane of the converging mirror 15 (on which the slit 17 is disposed in Fig. 3) is given by \( Y_1 = Y_{o}f_2/f_1 \). On the other hand, letting the distance between the center axes 24A and 25A of the two polarized beams 24 and 25 shifted by the Savart plate 12 described previously with respect to Fig. 6 and the diameter of the light emitting end face of the light source 11 be represented by \( d \) and \( R \) respectively, the diameters of the two apparent light sources 11a and 11b are also \( d + R \) and the center-to-center distance therebetween is also \( d \). Accordingly, the length of a segment which transverses the two light sources 11a and 11b in the Z-axis direction (i.e., the distance from the lower end of the light source 11a to the upper end of the light source 11b) is \( d + R \). Incidentally, to prevent overlapping of the two light sources 11a and 11b, the distance \( d \) between the two optical axes caused by the thickness of the Savart plate 12 and the diameter of the light emitting end face of the light source 11 are selected so that \( d > R \). Replacing the height \( Y_1 \) of the above-mentioned object in the Z-axis direction with \( d + R \), the distance between the outermost edges of the pair images of the light sources 11a and 11b which are formed on the focal plane of the converging mirror 15 is expressed by \((d + R)f_2/f_1\). The height of the slit 17 can be made minimum on the focal plane of the converging mirror 15, but it must be selected slightly larger than \((d + R)f_2/f_1\).

The photodetector 16 receives the two polarized beams of the same wavelength as that of the wave components separated from the two polarized beams 24 and 25 and, for each wavelength, creates an electric signal corresponding to the sum of the powers of the two polarized beams. The electric signal from the photodetector 16 corresponding to the sum of the powers of the two polarized waves for each wavelength will not change even with the rotation of the plane of polarization of the light to be measured, and consequently, the electric signal retains a constant value for the rotation of the plane of polarization without being affected by the polarization dependency of the dispersing element 14.

The reason for this will hereinafter be described, through the aid of mathematical expressions, in connection with the case where a diffraction grating is employed as the dispersing element 14.

Incident light and emitted light from a diffraction grating with no measures taken against its polarization dependency are given by the following expressions (1) and (2):

\[
P_{i}(\lambda) = P_{i}(\lambda, p) + P_{i}(\lambda, s) \quad (1)
\]

\[
P_{e}(\lambda) = f(\lambda)P_{i}(\lambda, p) + g(\lambda)P_{i}(\lambda, s) \quad (2)
\]

In the above, \( P_{i}(\lambda) \) is the quantity (i.e., power) of incident light of wavelength \( \lambda \); \( P_{i}(\lambda, p) \) is the quantity of light of the polarization component \( p \) in the direction of the grooves of the diffraction grating, contained in the incident light \( P_{i}(\lambda) \); \( P_{i}(\lambda, s) \) is the quantity of light of the polarization component \( s \) perpendicular to the direction of the grooves of the diffraction grating, contained in the incident light \( P_{i}(\lambda) \); \( P_{e}(\lambda) \) is the quantity of emitted light of the diffracted component of wavelength \( \lambda \); \( f(\lambda) \) is the diffraction efficiency for a polarized wave parallel (component \( p \)) to the grooves \( U \) (see Fig. 8); and \( g(\lambda) \) is the diffraction efficiency for a polarized wave perpendicular (component \( s \)) to the grooves \( U \) (see Fig. 8). The expression (2) indicates that even if the power of the incident light is constant, a change in the state of polarization will change the power \( P_{e}(\lambda) \) of diffracted wave component, that is, change the total diffraction efficiency.

In contrast thereto, according to the present invention, the incident light \( P_{i}(\lambda) \) is separated by the double-image polarizing element into two beams whose planes of polarization are at \( \pm 45^\circ \) to the grooves of the diffraction grating. Consequently, the incident light to the diffraction grating is expressed as follows:

\[
P_{i}(\lambda) = P_{i}^+ + P_{i}^- \quad (3)
\]

where \( P_{i}^+ \) is the quantity of incident light of the polarized component tilted at \( +45^\circ \) to the grooves of the diffraction grating, and \( P_{i}^- \) is the quantity of incident light of the polarized component tilted at \( -45^\circ \) to the grooves of the diffraction grating. Where the polarized components \( P_{i}^+ \) and \( P_{i}^- \) are incident to the diffraction grating, they are separated to the direction along the grooves of the diffraction grating and the direction perpendicular thereto as indicated by the following expressions:

\[
P_{i}^+ = P_{i}^+ + P_{i}^+ \quad (4)
\]

\[
P_{i}^- = P_{i}^- + P_{i}^- \quad (5)
\]

Therefore, the quantities of emitted light for the respective polarized components are expressed as follows:
\[ P_{at}^{\pm}(\lambda) = f(\lambda)P_{in}^{\pm}(\lambda, p) + g(\lambda)P_{in}^{\pm}(\lambda, s) \] (6)
\[ P_{at}^{-}(\lambda) = f(\lambda)P_{in}^{-}(\lambda, p) + g(\lambda)P_{in}^{-}(\lambda, s) \] (7)

Where the plane of polarization of the incident light is tilted at \( \pm 45^\circ \) to the grooves of the diffraction grating, the quantities of the light component (the polarization component \( p \)) along the grooves of the diffraction grating and the light component (the polarization component \( s \)) perpendicular thereto are equal to each other and are 1/2 the quantity of the incident light. That is, the following equations hold:
\[ P_{in}^{\pm}(\lambda, p) = P_{in}^{\pm}(\lambda, s) = P_{in}^{\pm}(\lambda)/2 \] (8)
\[ P_{in}^{-}(\lambda, p) = P_{in}^{-}(\lambda, s) = P_{in}^{-}(\lambda)/2 \] (9)

From expressions (6), (8) and expressions (7), (9) the following expressions hold:
\[ P_{at}^{\pm}(\lambda) = P_{in}^{\pm}(\lambda)(f(\lambda) + g(\lambda))/2 \] (10)
\[ P_{at}^{-}(\lambda) = P_{in}^{-}(\lambda)(f(\lambda) + g(\lambda))/2 \] (11)

Accordingly, the whole quantity of light, \( P_{at}(\lambda) \), emitted from the diffraction grating is given by the following expression:
\[ P_{at}(\lambda) = P_{at}^{+}(\lambda) + P_{at}^{-}(\lambda) = \{f(\lambda) + g(\lambda)\}[P_{in}^{+}(\lambda) + P_{in}^{-}(\lambda)]/2 = \{f(\lambda) + g(\lambda)\}P_{in}(\lambda)/2 \] ... (12)

As will be seen from expression (12), the diffraction efficiency assumes always the mean value of \( f(\lambda) \) and \( g(\lambda) \) and remains constant for the incident light and does not depend on the state of polarization of the incident light. This verification applies as well to dispersing elements other than the diffraction grating.

Fig. 9 illustrates another embodiment of the present invention, which employs, as the double-image polarizing element 12, a double Wollaston prism disposed between the collimator mirror 13 and the diffraction grating 14. The double Wollaston prism 12 has an arrangement in which two Wollaston prisms 12a and 12b are disposed on the common optical axis Ox but turned 90° apart as shown in Figs. 10A and 10B which are its side and plan views, respectively. With this structure, as shown in Fig. 11A, the beam 21 incident to the first Wollaston prism 12a is split in the Z-axis direction into two beams 22 and 23 polarized perpendicularly to each other and these beams 22 and 23 are shifted by the second Wollaston prism 12b from each other in the Y-axis direction perpendicular to the optical axis Ox and the Z-axis while their directions of polarization are maintained and are emitted as the beams 24 and 25. Accordingly, by turning the double Wollaston prism 12 45° about the optical axis Ox, the beams 24 and 25 are obtained which have their planes of polarization \( \pm 45° \) to the Z-axis direction and are spaced apart in the Z-axis direction as in the case described previously with respect to Figs. 5C and 5D. By applying such beams 24 and 25 to the diffraction grating 14 so that the Z-axis direction is parallel to the center axis Oz of rotation of the diffraction grating 14, the powers of separated wavelength components in the two polarized light components, which are not dependent on the direction of polarization can be detected by the photodetector as in the embodiment described above with respect to Fig. 3.

As described above, the present invention offers spectrum measuring equipment free from the polarization dependency of the dispersing element 14, ensuring accurate detection of the absolute value of optical power. Further, the present invention does not require the preparation of correction data in a memory for eliminating the polarization dependency of the dispersing element, and hence does not involve loading of the correction data. Consequently, the spectrum measuring equipment of the present invention is easy to manufacture.

Besides, since it is possible to continuously vary the wavelength and measure the quantity of light at a desired wavelength without employing the correction data, no limitations are imposed on resolution for the direction of wavelength. Hence, the accuracy of measurement can be enhanced by increasing the accuracy of the optical system.

While in the above the photodetector 16 is described to obtain the sum of optical powers of two polarized wave components, it is also possible to employ an arrangement in which the powers of the two polarized wave components are individually measured by two photodetectors and the measured values are added together. The photodetector 16 is not limited specifically to the photodiode but it may also be constructed so that two polarized wave components are incident on and transmitted over a glass fiber, for example, and are then subjected to a photoelectric conversion or input as light into other measuring equipment.

The dispersing element 14 need not always be a diffraction grating but may be a prism or the like. By using a concave diffraction grating as the dispersing element 14, the collimator mirror 13 can be omitted.

Moreover, the double-image polarizing element is not limited specifically to the Savart plate and the double Wollaston prism but other double-image polarizing elements can be employed.
Claims

1. Spectrum measuring equipment comprising:
   a double-image polarizing element (12) for splitting light to be measured into two polarized light
   components which have their planes of polarization orthogonal to each other and have different optical
   axes;
   a dispersing element (14) which is irradiated by said two polarized light components from said double-
   image polarizing element (12) so that the planes of polarization of said two polarized light components
   cross the direction of light separation at an angle of ±45° thereto, respectively, and whereby each of said
   two polarized light components is separated into individual wavelength components, components of the
   same wavelength in said two polarized light components having the same angle of separation; and
   light-quantity measuring means (16) for measuring the sum of the quantities of light of the two po-
   larized light components of the same wavelength separated by said dispersing element (14).

2. The spectrum measuring equipment according to claim 1, wherein said dispersing element (14) is a dif-
   fraction grating.

3. The spectrum measuring equipment according to claim 1 or 2, further comprising collimator means (13)
   for collimating each of said two polarized light components emitted from said double-image polarizing
   element (12) and then applying them to said dispersing element (14).

4. The spectrum measuring equipment according to claim 1, 2 or 3, wherein said double-image polarizing
   element (12) is a Savart plate.

5. The spectrum measuring equipment according to claim 1 or 2, further comprising collimator means (13)
   upon which said light to be measured is incident and for collimating said light to be measured and then
   applying it to said double-image polarizing element (12).

6. The spectrum measuring equipment according to claim 1, 2 or 5, wherein said double-image polarizing
   element (12) is a double Wollaston prism.

7. The spectrum measuring equipment according to claim 6, wherein said double Wollaston prism is com-
   posed of two Wollaston prisms disposed on the same optical axis with their directions of separation of
   polarized light held at right angles to each other.

8. The spectrum measuring equipment according to any one of claims 1 to 7, further comprising converging
   means (15) upon which said two polarized light components separated by said dispersing element (14)
   are incident and for converging them onto said light-quantity measuring means (16).

9. The spectrum measuring equipment according to any one of claims 1 to 8, wherein said light quantity
   measuring means (16) is a single photodetector which is irradiated by said two polarized light components
   and outputs an electric signal corresponding to the sum of their optical powers.

10. The spectrum measuring equipment according to any one of claims 1 to 8, wherein said light-quantity
    measuring means (16) includes a slit (17) whereby separated wavelength components of said two po-
    larized light components from said dispersing element (14) are selectively extracted, the width of said slit
    (17) being selected dependent on the wavelength resolution and the length of said slit (17) being selected
    such that each of said polarized light components passes therethrough without being cut off in a direction
    perpendicular to said direction of light separation.

11. The spectrum measuring equipment according to any one of claims 1 to 8, wherein said double-image
    polarizing element (12) is disposed so that said two polarized light components are shifted from each other
    in a direction perpendicular to said direction of light separation.

Patentansprüche

1. Spektralmeßanordnung, umfassend:
   ein Doppelbildpolarisationselement (12) zum Auftreffen von zu messendem Licht in zwei polarisierte
Lichtkomponenten, deren Polarisationsebenen orthogonal zueinander sind und die verschiedene optische Achsen aufweisen,

1. Streuungselement (14), das mit den beiden polarisierten Lichtkomponenten von dem Doppelbildpolarisationselement (12) bestrahlt wird derart, daß die Polarisationsebenen der beiden polarisierten Lichtkomponenten die Richtung der Lichttrennung unter einem jeweiligen Winkel von ±45° kreuzen, und wodurch jede der beiden polarisierten Lichtkomponenten in einzelne Wellenlängenkomponenten zerlegt wird und die Komponenten derselben Wellenlänge in den beiden polarisierten Lichtkomponenten derselben Trennungswinkel aufweisen, und

eine Lichtmengenmeßeinrichtung (16) zur Messung der Summe der Lichtmengen der beiden polarisierten Lichtkomponenten derselben Wellenlänge, die von dem Streuungselement (14) zerlegt wurden.

2. Spektralmeßanordnung nach Anspruch 1, bei dem das Streuungselement (14) ein Beugungsgitter ist.

3. Spektralmeßanordnung nach Anspruch 1 oder 2, ferner umfassend eine Kollimatoreinrichtung (13) zum Kollimieren jeder der beiden polarisierten Lichtkomponenten, die von dem Doppelbildpolarisationselement (12) emittiert werden und zu deren nachfolgendem Anlegen an das Streuungselement (14).

4. Spektralmeßanordnung nach Anspruch 1, 2 oder 3, bei dem das Doppelbildpolarisationselement (12) eine Savart-Platte ist.

5. Spektralmeßanordnung nach Anspruch 1 oder 2, ferner umfassend eine Kollimatoreinrichtung (13), auf die das zu messende Licht auftrifft, zum Kollimieren des zu messenden Lichts und zu seinem nachfolgenden Anlegen an das Doppelbildpolarisationselement (12).

6. Spektralmeßanordnung nach Anspruch 1, 2 oder 5, bei dem das Doppelbildpolarisationselement (12) ein Doppel-Wollaston- Prism ist.

7. Spektralmeßanordnung nach Anspruch 6, bei dem das Doppel-Wollaston-Prisma aus zwei Wollaston-Prismen zusammengesetzt ist, die auf derselben optischen Achse angeordnet sind, wobei ihre Richtungen der Trennung von polarisiertem Licht rechtwinklig zueinander gehalten werden.

8. Spektralmeßanordnung nach einem der Ansprüche 1 bis 7, ferner umfassend eine Konvergenzeinrichtung (15), auf die die beiden polarisierten Lichtkomponenten, die von dem Streuungselement (14) aufgetrennt wurden, auftreffen, um sie zu der Lichtmengenmeßeinrichtung (16) zu konvergieren.

9. Spektralmeßanordnung nach einem der Ansprüche 1 bis 8, bei dem die Lichtmengenmeßeinrichtung (16) ein einzelner Photodetektor ist, der mit den beiden polarisierten Lichtkomponenten bestrahlt wird und ein elektrisches Signal entsprechend der Summe ihrer optischen Leistungen abgibt.

10. Spektralmeßanordnung nach einem der Ansprüche 1 bis 8, bei dem die Lichtmengenmeßeinrichtung (16) einen Schlitze (17) enthält, wodurch aufgetrennte Wellenlängenkomponenten der beiden polarisierten Lichtkomponenten von dem Streuungselement (14) selektiv extrahiert werden, wobei die Breite des Schlitze (17) abhängig von der Wellenlängenauflösung gewählt ist und die Länge des Schlitze (17) derart gewählt ist, daß jede der polarisierten Lichtkomponenten hindurchgeht, ohne in einer Richtung senkrecht zur Richtung der Lichttrennung abgeschnitten zu werden.

11. Spektralmeßanordnung nach einem der Ansprüche 1 bis 8, bei dem das Doppelbildpolarisationselement (12) so angeordnet ist, daß die beiden polarisierten Lichtkomponenten gegeneinander in einer Richtung senkrecht zur Richtung der Lichttrennung verschoben werden.

Revendications

1. Equipement de mesure de spectre comprenant:
   un élément polarisant à double image (12) pour diviser la lumière à mesurer en deux composantes de lumière polarisée qui ont leurs plans de polarisation orthogonaux l’un à l’autre et qui ont des axes optiques différents;
   un élément dispersant (14) qui est éclairé par lesdites deux composantes de lumière polarisée is-
sues dudit élément polarisant à double image (12) de sorte que les plans de polarisation des dites deux composantes de lumière polarisée coupent la direction de séparation de lumière, respectivement, à des angles de ±45° par rapport à celle-ci, et par lequel chacune des dites deux composantes de lumière polarisée est séparée en composantes de longueurs d'onde individuelles, les composantes de la même longueur d'onde dans les deux composantes de lumière polarisée ayant le même angle de séparation ; et un moyen de mesure de quantité de lumière (16) pour mesurer la somme des quantités de lumière des deux composantes de lumière polarisée de la même longueur d'onde séparées par ledit élément dispersant (14).

2. Équipement de mesure de spectre selon la revendication 1, dans lequel ledit élément dispersant (14) est un réseau de diffraction.

3. Équipement de mesure de spectre selon la revendication 1 ou 2, comprenant en outre un moyen collimateur (13) pour collimater chacune des dites deux composantes de lumière polarisée émises par ledit élément polarisant à double image (12) et pour les appliquer audit élément dispersant (14).

4. Équipement de mesure de spectre selon la revendication 1, 2 ou 3, dans lequel ledit élément polarisant à double image (12) est une lame de Savart.

5. Équipement de mesure de spectre selon la revendication 1 ou 2, comprenant en outre un moyen collimateur (13) sur lequel ladite lumière à mesurer est incidente, pour collimater ladite lumière à mesurer et l'appliquer ensuite audit élément polarisant à double image (12).

6. Équipement de mesure de spectre selon la revendication 1, 2 ou 5, dans lequel ledit élément polarisant à double image (12) est un prisme de Wollaston double.

7. Équipement de mesure de spectre selon la revendication 6, dans lequel ledit prisme de Wollaston double est composé de deux prismes de Wollaston disposés sur le même axe optique, leurs directions de séparation de lumière polarisée étant maintenues à angle droit l'une de l'autre.

8. Équipement de mesure de spectre selon l'une quelconque des revendications 1 à 7, comprenant en outre un moyen de convergence (15) sur lequel lesdites deux composantes de lumière polarisée séparées par ledit élément dispersant (14) sont incidentes, pour les faire converger sur ledit moyen de mesure de quantité de lumière (16).

9. Équipement de mesure de spectre selon l'une quelconque des revendications 1 à 8, dans lequel ledit moyen de mesure de quantité de lumière (16) est un photodétecteur unique qui est éclairé par lesdites deux composantes de lumière polarisée et qui sort un signal électrique correspondant à la somme de leurs puissances optiques.

10. Équipement de mesure de spectre selon l'une quelconque des revendications 1 à 8, dans lequel ledit moyen de mesure de quantité de lumière (16) comprend une fente (17) par laquelle les deux composantes de longueur d'onde séparées des dites deux composantes de lumière polarisée issues de l'élément dispersant (14) sont extraites de manière sélective, la largeur de ladite fente (17) étant choisie en fonction de la définition de longueur d'onde, et la longueur de ladite fente (17) étant choisie de telle manière que chacune desdites composantes de lumière polarisée la traverse sans être supprimée dans une direction perpendiculaire à ladite direction de séparation de lumière.

11. Équipement de mesure de spectre selon l'une quelconque des revendications 1 à 8, dans lequel ledit élément polarisant à double image (12) est disposé de telle manière que lesdites deux composantes de lumière polarisée soient décalées l'une par rapport à l'autre dans une direction perpendiculaire à ladite direction de séparation de lumière.
FIG. 1 PRIOR ART

FIG. 2 PRIOR ART